The Compass Machine.

BY C. H. CLAUDY.

Uncounted millions of dollars, innumerable human lives, and goodly ships without number, depend for safety on the performance of a little engine, almost small enough to go into a silk hat, called the compass machine. There are but few of them in existence, but these few cut the majority of compass cards on the charts of the coasts of the world.

What is a compass card, how it is cut, and why and how can so much depend on so little?

When the United States Coast and Geodetic Survey completes a copper plate, bearing on its surface the patient engraving of many men for many moons, the work of half a hundred survey parties and the expenditure of thousands of dollars, they have, in its then form something which, printed, would be worse than useless to a mariner, He must be able to know, and know accurately, which is north and which is south, east and west. To accomplish this, there are cut into the copper, one or more compass cards, circles graduated in degrees and in mariner's points, and the accuracy must be absolute, for a deviation of a fraction of an inch too small to see, would make a difference of miles when the direction is extended to the further portions of the chart with the parallel rulers.

For a long time compass cards were cut by hand. They had first to be laid out on the plate, a very difficult and dainty operation, and then engraved by hand. From three to four days were usually required for an expert engraver to cut one of these cards. Now, however, the cards are cut by a machine, more accurately than is possible by hand, and instead of taking three days for one card, the engraver now does three cards in one day.

The machine, while automatic, is worked by hand, that is, it is manual power

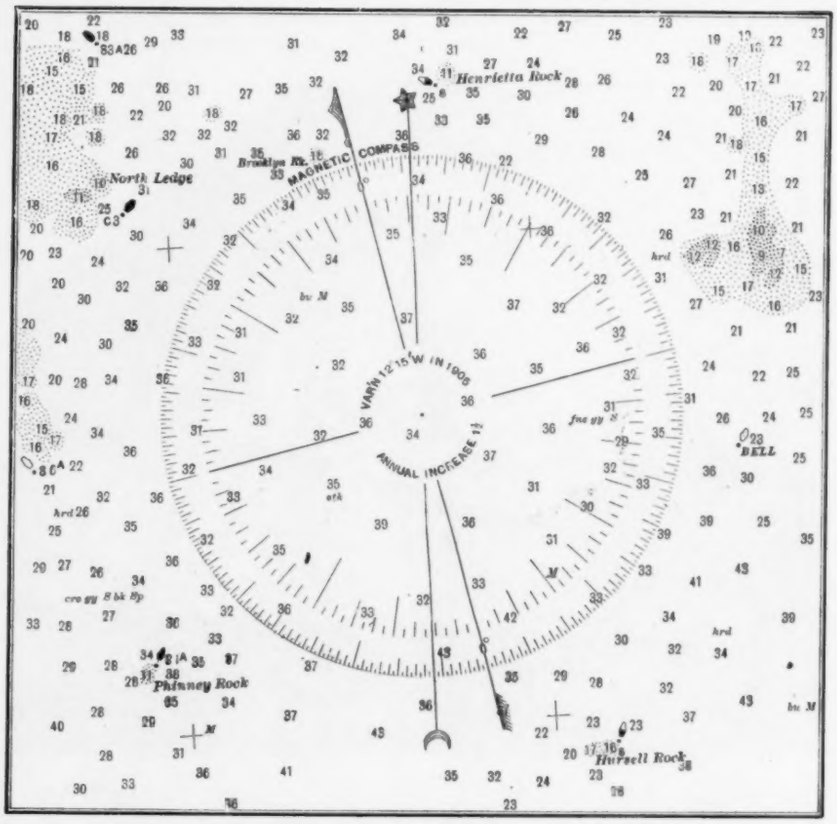


FIG. 1. SECTION OF MARINER'S CHART SHOWING COMPASS CARD.

which moves the mechanism for each cut, but the graduations, the circles, the length of the lines, all are managed by the very delicate and accurate machinery. Finally, the whole thing is simple and does not get out of order.

Reference to the illustrations will show that the machine consists first of a metal ring with a second ring fitting accurately in the first and revolvable inside it. On this second ring the mechanism is mounted. The first ring is fastened to the copper plate with stiff tough wax, over the space to be occupied by the card when it is cut.

On the inner ring is seen a standard from which are hung two pendulum arms, supporting the graver rod, which swings freely between them. On the graver rod is mounted a circular can, filled with shot, to give enough weight to the point to make it bite into the copper. The free end of the graver rod impinges on a small pyramid of wheels, with indentations in their edges of different depths. These wheels are connected to the back-and-forth mechanism so that they revolve the proper distance to bring the right indentation before the end of the rod, to allow the rod to make the line of the proper length. Refer to the illustration showing the card itself, and notice how the degree and multiple degree marks differ in length.

By means of a delicate rack and screw movement, the entire graving mechanism moves the proper distance around the circle between each cut, the return of the graver for a new stroke automatically accomplishing this, the essential part of the work. And the mechanism is so adjusted that no matter what size card is being cut, the degree marks and the mariners points automatically adjust themselves to the size of the circle.

Of course it requires skill to use the instrument, mainly in seeing that it is accurately set for the first cut, but when the work is done by the machine with a skilled engraver at the helm, he makes about a thousand per cent. better time than he could the old way and the work cannot suffer from any personal equation, or any slip of the hand.

A clever adaption of the pantographic principle completes this little engine. After the cutting is completed, the engraving mechanism is removed from the ring and another shown in Fig. 3 is substituted, which is arranged to cut figures and letters. Parallel lateral standards allow the mechanism to be shifted from side to side and the whole revolves so that the graver may be brought over any point in the plate inside the circle. The graver is upright and ends in a can of shot as before, from the top of which depends a curved yoke ending in a handle movable through the yoke, which handle ends in a round point. The curve of the yoke fits over a plate on the top of which are engraved, intalgio and reversed, letters and figures. This plate revolves about its center and is locked in position by the split handle seen at the top. When the round point of the handle working in the yoke is dropped into the engraved letter or figure and the point made to follow the outline, the graver point below, makes a similar outline reversed upon the copper plate. For the lower end of the graver rod is hung in gimbals, and the whole is nothing but an upright pantograph of novel form. By this means the machine-made circles and divisions are lettered and numbered accurately and quickly, the line of letters following the curve of the circle of the compass.

The device was the invention of Vincent Ourdan, a man described by those who knew him as rather uneducated and unlettered but a genius at applied me-

chanics. The United States, Japan, Russia, Germany and England are now using these machines in their work, which bears out the opening assertion that untold numbers of dollars, lives, and ships depend for safety on this little machine. For if the compass was not accurately cut navigation by the chart on which the inaccurate compass was cut would be worse than suicide, and while, of course, every compass card is inspected and rigorously tested for accuracy after being cut, still an undetected error in one single division of a degree could do as much deadly work as a whole compass out of gear.

In the illustration of the compass card, numbers of small figures will be seen. These have nothing to do with the card—they are soundings, indicating the depth of water in fathoms.

Echoes from the Oil Country—Odd Types of Engines—Gas Cylinders in Place of Steam—Running with Either Gas or Steam or Both.

When I read of the relics of a past age that are from time to time unearthed, and follow the reasoning of some archeologist as to the practices of our forefathers I feel sorry that he has so little material to work with. With more material he might have better foundation for his groundwork of reasoning. As it is often hard to judge of the things of today correctly when an abundance of material is at hand but some important link is missing, I can to some extent realize the difficulty of judging of the times of centuries ago by a few scattered and disconnected specimens.

I can imagine some savant of the Thirty-ninth Century proving that the gas engine was evolved from the steam engine, and his brother savant contending that the reverse is the case and that the gas engine came first. Oil is a good preservative and there is enough material here in the oil country that needs only to be buried after having a sufficient coating of oil to furnish plenty of ground for the contention of either.

Everybody knows what a steam engine is from observation, and nearly everybody has seen a gas engine, and those who have not have read about them until they feel acquainted anyhow, but I think there are engines in the country here that very few who do not belong in the oil country know anything about. For want of a better name they might be called steam-gas engines, or gas-steam engines. These engines are not merely inventors' models, but are machines that have had or are yet having a practical use.

I will not attempt to tell of them in the order of their development, nor in the order of their importance, but will try to give an idea of some of them.

Many of these machines were developed because of the fear that the gas engine could not be handled with certainty, and it was desired to make sure of being able to run it, or because of lack of faith in the lasting qualities of the gas supply, and some of them were made because they were cheaper than anything else that could be made.

One of the best known and most widely used of these "crosses" is a two-cycle cylinder designed to fit into place instead of a steam cylinder. The charge is drawn into the front end of the cylinder and from there passes into the back end at the the proper time and then is compressed and fired. A clutch pulley replaces the regular engine pulley and a small eccentric gives motion to the inlet valve that also acts as governor. As the balance of

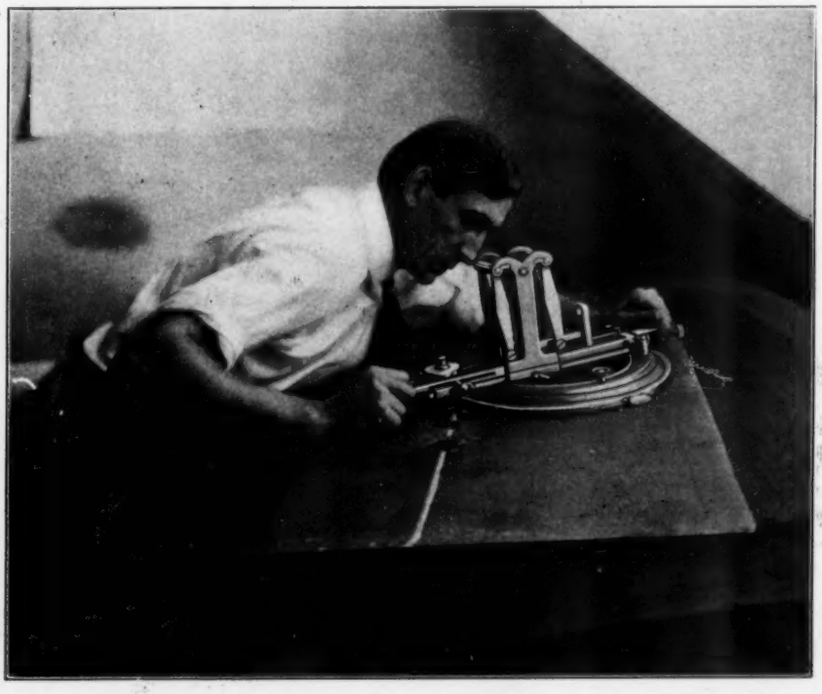


FIG. 2. CUTTING A COMPASS CARD ON A COPPER PLATE WITH THE COMPASS MACHINE.

the steam engine is used there is a decided saving over getting a complete engine, more particularly as old steam engines are a drug on the market. Even if not very efficient from a mechanical standpoint, nor very economical in the use of gas, yet they have found a place in a land where gas is part of the product of the land, and where not much power is required. The very low cost makes up for quite a lot of other things. Gas engines are handled by all sorts of people and it is not strange to find numbers of them who are not mechanically inclined, and who never study their engines. It is not to be wondered at that such people often have trouble in getting their engine to going, nor is it to be wondered at that they never blame it on themselves but always blame it on the engine.

To make an engine suited to the needs of this class of people a cylinder has been designed that goes on back of the steam cylinder. The piston rod of the gas-engine cylinder is made to connect on to the steam-engine piston and here is an engine that will run with either gas or steam, or both. It can be started with steam and the gas turned on and experimented with until it is coaxed to take hold, and then if desired the steam can be shut off until the next starting time. With wells that have to be steamed it is necessary to have a steam boiler and in such cases this type has found some friends.

It would seem as though someone thought the idea a good one, but did not think it was carried out as well as it could be, for there is one engine made to use steam in one end of the cylinder and gas in the other end.

The gas end of this cylinder of course works on the four-cycle plan and so has to have a two-to-one motion for the valves. This engine is designed to be run with either gas or steam or both.

That a man may be able to suit himself in the matter of how he will produce his power another cylinder is made to be used either for steam or for gas. To convert it from one to the other certain changes have to be made. The steam and gas work in the same place, but only one can be used at a time. This has been a development of the territory where water abounds in the oil-bearing rock. It must be understood that a large part of the gas used to operate engines in the oil country where they are employed to pump the wells comes from the wells that the engine pumps. Where there is water if the engine stops the water fills in and often stops the supply of gas and before it can be gotten again the water must be

exhausted. This combination engine can be used to pump until the gas comes again and then changed over to go on and work with gas. The enterprising geniuses who found that they could run their regular gas engines with gasolene, or if necessary, with crude oil, without making any change in the engine, but by using a little patience and judgment, rather curtailed the sphere of this type of engine.

That no man need be out of style on account of not being able to draw on a plethoric bank account plans have been made to convert steam engines into gas engines with very little expense. In some cases very little beyond a new piston head and new cylinder head, a couple of valves and an igniter is necessary. These devices are often the product of a job shop and are not known outside of a very limited range. They are made on too close a margin to make it possible to do much advertising, and are not gotten up and made in a style to appeal to a man looking for something up-to-date and intended for continuous hard work.

This does not exhaust the list, but will show that a very plausible case of evolution might be worked out by an expert with this evidence at hand.

Quite a number of varieties of some of these types have been made, and they have not been merely interesting experiments as thousands of them have been made and put into use. Not any of them are complete engines, but cylinders which are used as attachments either to supplement or replace the cylinders of existing steam engines.

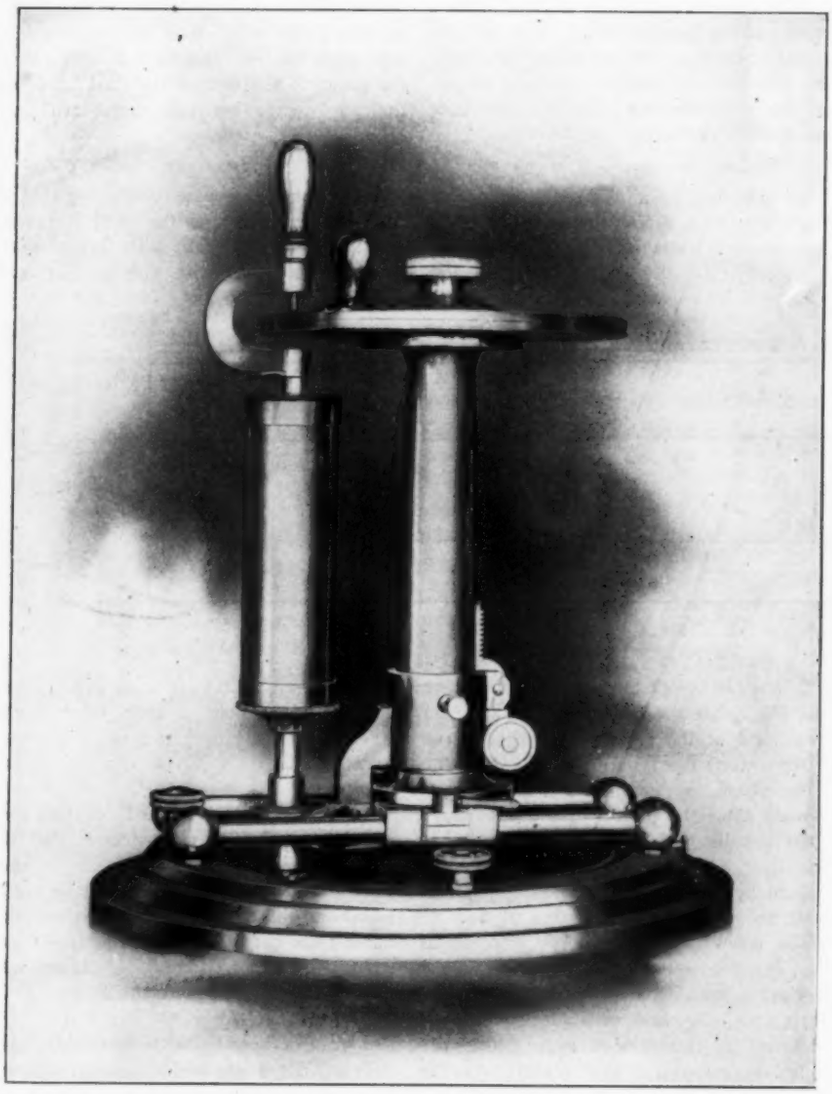


FIG. 3. COMPASS MACHINE ARRANGED FOR ENGRAVING LETTERS AND FIGURES.

Viewed from either a mechanical or a theoretical standpoint they may not have attained a very high rank, but they have helped to give the world cheap light and made it possible to produce oil in very low-grade territory where the production per well is only the fraction of a barrel, and not the major fraction either.

W. OSBORNE.

The works for the clock made for the cathedral of St. Gervais d'Avranche (Manche) weigh two tons.

The Dining Room of a British Engineering Works.

In an article in *Engineering*, of London, describing the works of the well known British firm of Barr & Stroud, the following interesting account of the dining arrangements at that plant is given:

Adjoining the dining-hall is a kitchen, fully equipped with coal and gas cooking-stoves, etc. The kitchen and restaurant are under the charge of a manageress, assisted by a cook and staff of seven maids. In this kitchen are also prepared the meals for the foremen, draftsmen, and lady typewriters, who dine consecutively in a room separate from the dining-hall. The absence of the foremen from the large dining-hall is in the interests of discipline in the shops, and the maintenance of order during meals is thus entirely intrusted to the men, who are most jealous guardians of the confidence reposed in them. The partners and senior members of the staff dine in the board-room on the first floor of the building. This room is served by a lift from the kitchen. As we have already said, the use of the dining-hall and the purchase of food from the firm are entirely voluntary; but, to legalize the sale of food, and prevent infringement of the Truck Acts, every employee is required to sign the following agreement on entering the services of the firm: "I, the undersigned, agree that should I purchase from Messrs. Barr and Stroud food cooked and to be eaten on their premises, I shall allow the value of such food to be deducted from my wages."

The dining-hall is a large, well-heated, well-lighted, and comfortable room on the ground-floor. It may be entered almost directly from the kitchen, but this entrance is exclusively reserved for the attendants and staff, the men using a separate door. Before coming in to dine, the men change their overalls and wash their hands at the basins freely distributed throughout the works, where every convenience in the way of towels and soap is provided, and lockers for each man's overalls are ranged against the walls. The tables are covered with a white oilcloth, and each table seats a "mess" of eight men. One of these is the mess president, who is responsible for order at his table. The mess presidents are elected in a body by the men, and hold office for twelve months. On election each president collects round him seven of his friends, and the party have a table allocated to them. One member of each mess, generally an apprentice, is the "orderly" for his table, and it is his duty to carry the food and empty plates to and from the serving tables; the kitchen staff do not go about among the men when the latter are seated.

A mess-card is supplied to each table, on which the men order the food they

will require the next day. On the back of the card is printed a standard menu, with a symbolic letter for each item, and the price opposite. Items such as fish, meat, pudding, etc., although they vary in kind, are, like the rest, supplied at fixed prices; but that the men may know what they are ordering beforehand, the kinds of meat and pudding which are to be supplied the next day are stated on a blackboard in the mess-room. The mess card is 8 inches long and 5 inches high, and is ruled with six horizontal columns corresponding to the days of the week, and with eight vertical columns, each headed with one of the men's numbers, the mess president's number being written in red ink. The "day" columns are subdivided into three smaller ones, for breakfast, dinner, and tea respectively, and the personal columns into two, headed respectively, "ordered" and "value." Each man fills in below his number and opposite the proper meal for the next day, the symbolic letters of his order, and it is the duty of the mess president to see that these items are properly entered. When the men enter the hall they find the tables laid and the first course of what they had ordered the day before set at their respective tables. The second course is fetched from the counter at the staff entrance by the orderly, so that it is received hot by the men.

The value of each meal is entered daily on each man's card, and at the end of the working week, when the cards are filled in, the total value of each man's purchases is entered at the foot of his column. The cards are then cut up into strips, and the column pertaining to each man is returned to him in his wages bag, so that he may compare his account with the amount deducted from his wages. The system works with exceptional smoothness (owing no doubt to the arrangements being under the control of the men themselves, who, if they feel aggrieved by anything, can bring the matter before the shop committee, who have absolute power to deal with the case). The charges made for food cover purchasing, cooking, depreciation, and working expenses, rent alone being borne by the firm, so that the dining-hall is self-supporting, a convenience for the men, and a business undertaking.

Molding a Draw-bench Casting in a Flask, and also by Using the Floor as a Drag and Bedding-in the Pattern.

BY R. H. PALMER.

In several articles I have described two different ways of molding from the same pattern, which is so made that it might be molded in a flask, and the drag rammed up and rolled over; or bedded in the floor, as the party making the casting wished. In the molding of the draw-bench casting here shown, I wish to call attention to the differences in the construction of the patterns required to allow them to be molded easily in the two different ways shown.

MAKING THE MOLD IN A FLASK.

For molding in a flask, the drag of which is to be rammed up and rolled over, the pattern is shown in Fig. 1, bottom up as when lying on the moldboard ready for the drag to be placed around it; Fig. 2 and Fig. 3 are the end views and Fig. 4 a side view of the pattern. In Fig. 4, the pattern has the coreprint, *C*, for the name-plate core, pinned on; it is drawn inward after the pattern has been drawn.

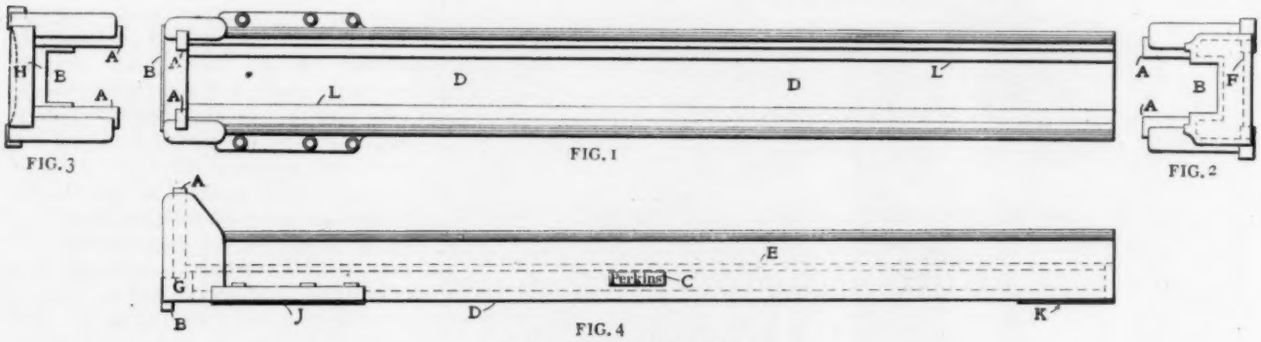


FIG. 4
PATTERN FOR DRAW-BENCH.

In molding in a flask the pattern is usually laid on a moldboard in the position shown by Fig. 4. Fig. 5 shows the drag, with the pattern on the board, dotted in. (The pieced-up flask will be understood by almost any molder.)

Facing sand is placed around the pattern and is backed with black sand and rammed to the desired hight along the sides, say to point *A*, Fig. 5, and also at the ends; the sand is now dug away in the end at point *B*, and gatestick *C* is set, and gate *D* later; the pattern is faced and rammed up to line *E*, on the sides and ends. The pattern is now cleaned off and faced, and black sand is covered over the facing to a depth of three inches; rods are clay-washed and stood on end in the sand in pattern as shown by *F F F F*; by referring to end view of pattern, Fig. 2, it will be seen that a green-sand core *D D*, Fig. 1, extends the whole length of the pattern on top, as the pattern now lies, and it is to secure this core that the rods *F* are set on end in the pattern as shown. The drag is now rammed full and struck off, the board is rubbed to a bearing, and taken off, and the mold is given a good venting. In some foundries it is the practice to nail pieces of thin stuff on the joint of the flask between drag and board, and when the drag has been rolled over to run a vent wire between the board and drag to bring off the gas from the vents already made in the mold. The board is now replaced and clamped on, and the drag is rolled over, then vented as above.

Another way to bring off the vent or gases in a case like this is to form a channel-way between the rods, and after venting the green-sand core fill the channel-way with cinders, and in this way bring the gases to the end of the flask, and let the gas escape between the board and drag.

THE COPE.

Loose piece of pattern *F*, Fig. 7, is placed in position and the joint is made, and the pattern covered with facing sand. The cope is now put on, and gaggers are set, gate-sticks for pouring gates, and flow-off. The cope is then rammed up, leaving open the bars through the center between Fig. 6, *X X*, some of which are marked *A A*.

The cope is now hoisted off, and part of pattern *F*, Fig. 7, is drawn, and the cope is finished. The pattern is then drawn from the drag, and the drag is finished and the cores *E*, Fig. 7, are set, also name-plate core *C*, Fig. 4, when used, and gates are cut for pouring, to connect with sprues to the runners from *B*, and *B X*, also flow-off *C* (Fig. 7).

Pieces of board the thickness the casting is wanted are laid on the green-sand core at *A*, Fig. 7, extending nearly the whole length of the mold, and the cores which are to form the inside of the casting are set on these boards; this may perhaps be better understood by referring to Fig. 11, *B*, and Fig. 2, *B*.

The cope is now lowered on the drag and hook-bolts are passed down between the bars at *A A*, Fig. 6, and hooked into staples in cores shown at *B B*, Fig. 6; wedges are shoved in between the bars *C*, and the cores. Gate-sticks are set to bring off the gases from the cores and the sand is rammed into the spaces between the bars which had been left open when the cope was rammed up; gate-sticks are removed,

and clamps *H*, Fig. 6, are laid along the top of the flask on each side of the hook-bolts; pieces of casting made for the purpose are passed down over the bolts as *D*, Fig. 6, and washers *E*, Fig. 6; nuts *F*, Fig. 6, are then tightened down on them, and thus the cores are fastened to the cope.

The cope is now hoisted off, and the cores *A A A A*, Fig. 8, are seen hanging to the cope, while on the top of the cope are seen the clamps, with the castings, washers and nuts. Pieces of board are removed from the drag, and the latter is given a coat of blacking; the cope is then tried on the drag to see that everything is all right. The runner *B*, Fig. 7 and flow-off *C*, are then built, and cope replaced and closed on for good, clamps *D* are placed, and we have the whole as in Fig. 7.

MOLDING BY BEDDING-IN, OR USING THE FLOOR FOR THE NOWEL.

We have molded the pattern in a flask, ramming up the drag and rolling it over; now let us make the same casting, and bed the pattern in the floor, and note where changes are desirable in the pattern to allow it to be easily bedded in the floor. As I have described a number of times the bottom of the pit, I will omit that part of the description.

In Fig. 10 is shown the cinder bed *A*; with gas-pipes *B* sticking up out of the floor, and eyebolts *C* below the floor line. The pit is rammed up to line *D*, and the pattern *E* is then placed in the pit resting on the wedges *F*, by means of which the pattern is leveled, and which are to be removed when the facing sand is tucked in under the pattern. The pattern is what is termed in the foundry a solid, or box pattern; that is, there are no pockets to be coped out as the inside of the pattern is cored out with cores seen hanging to the cope in Fig. 8 at *A A*.

In making the pattern for bedding-in, the part *D*, Fig. 4, of it, or the cope side, is not fastened in, but is laid in loosely, resting in the sides (I think the pattern-makers call it "shouldered-in"); while the part *E*, Fig. 4, which was also solid in the pattern used for molding in a flask, is this time left out altogether, thus leaving the pattern open where plate *D* is shown in Fig. 1; the pattern is fastened together in the middle at two places by crosspieces or braces. Facing sand is now tucked under the pattern from the outside, and loose pieces *D*, Fig. 4, are removed, and the facing sand is also tucked under from the inside, or through the center of pattern where the plate *D* is left out, and the wedges are removed. Gate-sticks are set at a proper time to pour the castings the same way as when it was molded in a drag flask; see Fig. 7 in which *H* is the gate-stick or upright and *I* is for the gate into the casting.

The pattern being faced, and rammed under, and on the outside up to the top, attention is given to ramming up the green-sand core along the center of the pattern. The sides are faced, and sand is rammed half way to the top of Fig. 11, *I*; rods such as were used in Fig. 5 *F*, and seen at *G G G*, Fig. 10, and *C*, Fig. 11, are now driven down in this green-sand core, and the sand is rammed, and tucked in around them, and the sand rammed nearly to the top, or within an inch or so of the top of *I*, Fig. 11. The core is then vented down to the cinder bed *A*, Fig. 10, and the top of the core is made up by hand to *B*, Fig. 11, and trued off with strike *J*, Fig. 11. The loose pieces of pattern *D*, Fig. 4, and *A*, Fig. 11, are placed on the pattern, and the joint is made.

The cope is staked with stakes *Q Q*, Fig. 8, and rammed up as it was when molded in a tight flask. It is then vented and hoisted off; the mold being finished, cores *X X*, Fig. 11, are set, also cores for coring out the center of the casting, and are fastened to the cope as in the first way

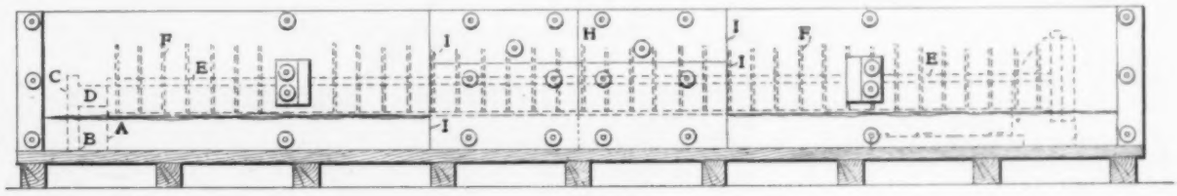


FIG. 5
PIECED-UP DRAG FLASK, PATTERN SHOWN BY DOTTED LINES.

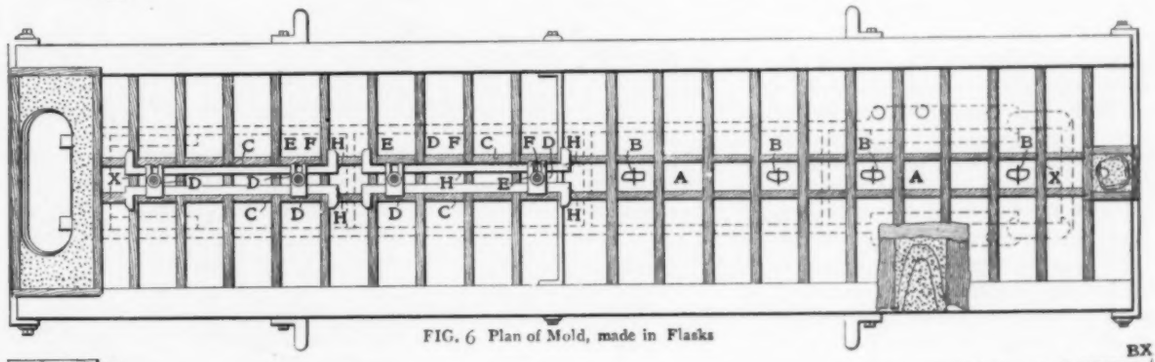


FIG. 6 Plan of Mold, made in Flasks

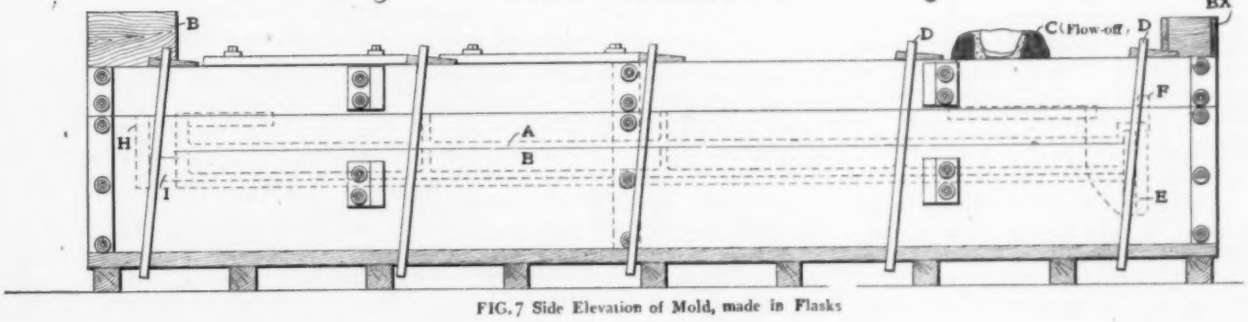


FIG. 7 Side Elevation of Mold, made in Flasks

of molding the pattern; the name-plate core is set, and held in print by spikes. By referring to Fig. 8, it can be seen at *B* how the cores butt together to form the transverse ribs. The cope, Fig. 8, is now lowered onto the floor line (shown in Fig. 9), being guided to position by stakes *Q Q*. Pieces of timber *H*, Fig. 11, are placed on the top of the sides of the flask, being high enough to carry the binders which are to secure the flask, or hold it down, above the clamps *C*, Fig. 8. These binders *D*, Fig. 11, are placed on *H*, and hook-

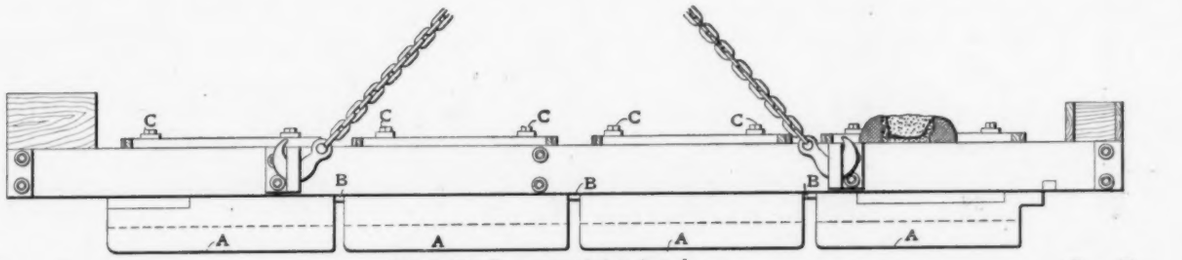


FIG. 8 The Cope suspended ready to lower

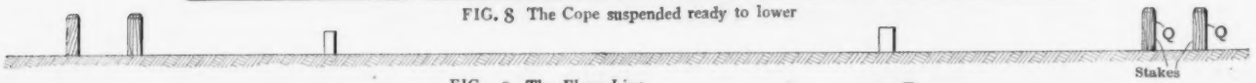


FIG. 9 The Floor Line

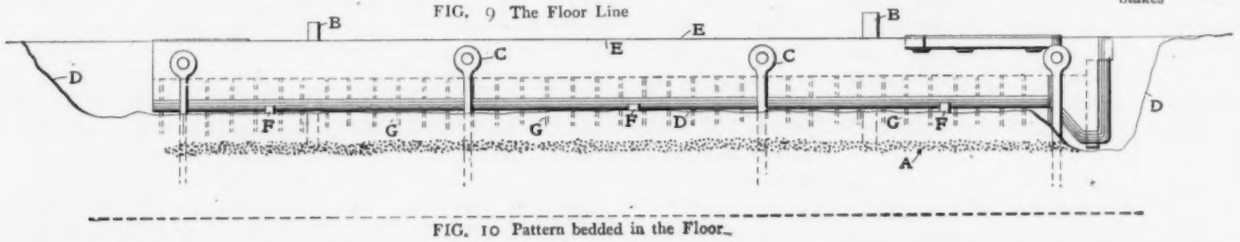


FIG. 10 Pattern bedded in the Floor.

bolts *E*, are hooked into eyebolts *C*, Fig. 10, and passed into slots in the binders; washers F, Fig. 11, are placed, and nuts *G* are screwed down on top of them.

It will be seen that I have, in the drawing, cut the binders off; these binders measure some 9 feet in length and are used on a great variety of work. In this case the flask is 3 feet 8 inches wide, and 15 feet 4 inches long. When this job came out of the pit, a job was put in using the same width of cope, but 19 feet 4 inches long; after that one which called for a flask wider, but shorter. Before the job spoken of was put in, there was one put in using a flask 16 feet long by 7 feet 6 inches wide, the casting weighing nearly 13 tons; I mention these examples to show what a variety of work this pit in connection with another smaller one is called on for, and the rigging described goes with both pits, while the cope has been used for four different jobs without cutting the bars, by lowering and raising the pattern; part of the patterns being irregular, and calling for the bars to be cut if molded as they would be under ordinary circumstances, with deep or shallow drags and copes.

COMPARISON OF THE PATTERNS.

As we have molded the patterns in two different ways, and the two patterns were made differently, let us look them over:

In the first we had a solid pattern, the only loose piece on it being the piece in the cope. When we made the green-sand core we made the part on which the iron was to lay between *L L*, Fig. 1, first; when we made the green-sand core on plate *D*, Fig. 1, *B*, Fig. 2, between *A A*, and vented down to the face we provided channel-ways for the gas to escape between the board and drag, from this face, and the sides of the green-sand core.

In the second pattern we had the top of pattern loose at *D*, Fig. 1. In our molding this pattern we reversed the making of the green-sand core, we made the foundation of the core first, providing for the gas to escape easily from the bottom of the mold and core by the use of cinders and gas pipe to bring it to the surface away from the mold; we started to ram the core at the bottom, and worked our way nearly to the top of the core, having rodded the core from the top, and vented it from the top, finally making up by hand the surface on which the iron is to lay, and truing it off with a strike.

The whole operation of bedding the pattern in the floor has been the reverse of molding it in a tight flask and rolling over the drag.

It is easily seen that to use the pattern as it was made for ramming up in a flask, to bed in the floor, would be awkward, to say the least; while it could be done, it could not be done as quickly as by having the pattern made as I have described. On the other hand were the pattern as made to be bedded in the floor, used in a flask, it would be as awkward to use as was the other in the case just supposed; but each, used in the way they were intended, *gives the best results.*

In making patterns for different classes of work we try, before the pattern is made, to take into consideration, the cost of molding it in the two different ways, also the number of castings to be made, and the cost of making the rigging in connection with what we already have on hand.

A mechanical engineer said to me one day, "I do not see how you make such a variety of work with so few flasks, and some of it is so heavy?" On showing him how the flasks were arranged to be interchangeable, and the rigging that went with the pits, he was able to see how it was done.

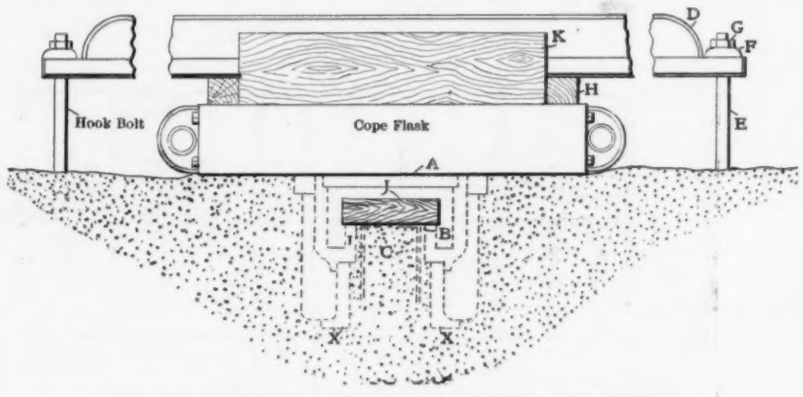


FIG. 11. TRANSVERSE SECTION OF MOLD BEDDED IN THE FLOOR.

As I have used quite a number of illustrations, I have not provided a drawing of the casting, believing that the reader could form a fair idea of it by looking at

the drawings of the pattern, and taking the dotted line in Fig. 3 as the top of the ribs and considering the core-prints *A A* as omitted, and imagining the slots made by these cores.

An English Slab-Milling Machine.

BY JAMES VOSE.

Messrs. J. Holroyd & Co., Ltd., Milnrow, Manchester, England, have recently completed, to the order of a large locomotive-building concern, a special high-speed slab-milling machine, designed for milling the sides of locomotive connecting rods, etc., and some particulars of the

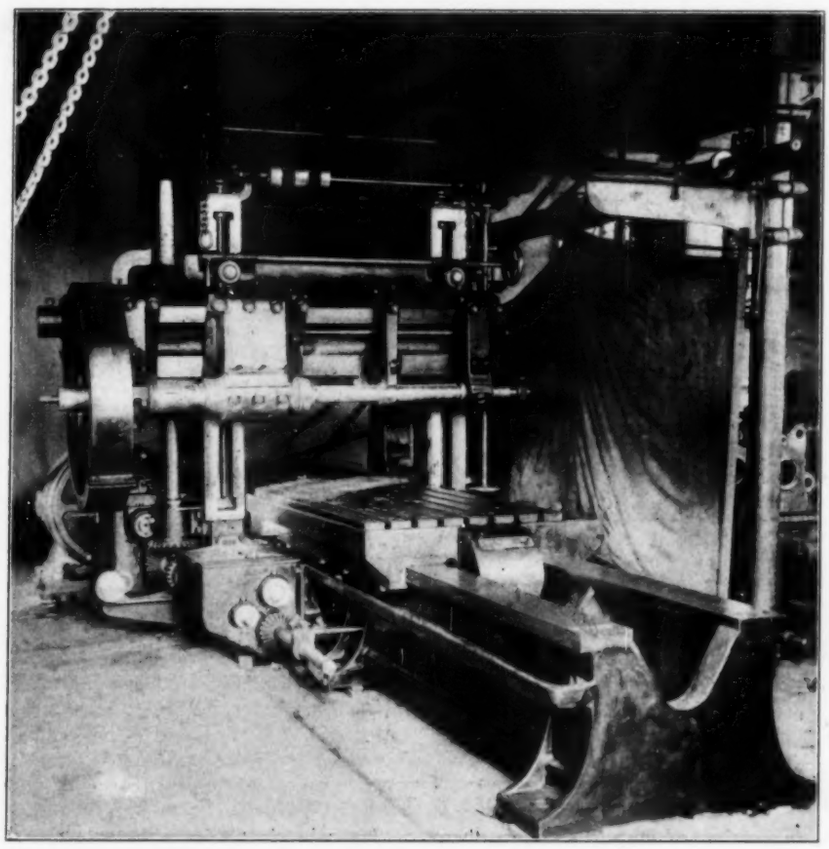


FIG. I. ENGLISH SLAB-MILLING MACHINE.

machine are here given. It is designed to work up to the possibilities of high-speed steel, a 45 horse-power variable speed motor being embodied as an integral part of the machine, the gears connecting the motor to the main driving shaft running in an oil bath, the shafts themselves running in self-oiling bearings.

The table has 7 T-slots for 1-inch bolts, and also square holes for end-stops for holding the work against the pressure of the cuts and the strains thus set up are fully provided for in the section of the table. Its rectangular dimensions—13 feet 6 inches x 3 feet 3 inches—allow of two connecting rods, each 12 inches across the widest part, and 12 feet 6 inches long being held. A trough round the sides catches the lubricant from the cutters, the overflow being collected by a trough along the side of the bed and led into a tank formed between the bars across the inside of the bed, from which it is circulated by a rotary pump.

The cross rail as shown in the general view, Fig. 1, is massive, the bearing surfaces upon the uprights being 2 feet 9 inches long. The slide carrying the spindle bracket set at the angle necessary for directly meeting the thrust, is of box section, and has quick up and down hand and power adjustments. It is balanced by weights which are placed in a pit under the machine. An improved locking arrangement is provided which is operated by a hand wheel located within easy reach of the operator.

The brackets and bearings carrying the shafts on the back of the cross-slide which drive the spindle are all cast solid, and a specially designed vertical self-oiling bearing is arranged to carry the bevel-driving pinions on the overhead shaft; a bearing is also fitted which supports the outer end of the shaft carrying the pinion which drives the main gear on the cutting spindle.

This spindle is of 40-point carbon steel, 5¾ inches diameter in the driving-wheel, and runs in hard bronze-capped bearings. One end is carried by an adjustable bracket with a bearing 16 inches long, and behind the collar—which has a slot cut across to drive the arbor—is a ball race to take the side thrust due to the spirality of the milling cutter teeth. It is driven by a spur wheel 3 feet 8 inches diameter x 6 inches face, the teeth being two inches pitch, and is bored taper to receive the cutter mandrel, the hole being continued parallel and carrying a rod used for drawing in or forcing out the arbor by means of a screw. The arbor is of nickel steel 3½ inches diameter, and 4 feet long on the part receiving the cutters. It is supported by an outer bearing with bronze steps which carry a bush through which the arbor passes. A central bearing materially contributes to the anti-vibratory support of the arbor.

The cutting-speeds range from 24 to 48 turns per minute, controlled by rheostat and the variable speed motor. The diameters of milling cutters vary from 6 to 12 inches, the cutting speed being 75 feet per minute. The feeds are positively driven from the second motion shaft through change gears giving 8 changes in geometrical progression from 2 to 12 inches per minute when the spindle is running at 24 turns per minute. The motion is transmitted from the gears in the gear-box to a worm and a wheel connected to a revolving nut in the center of the bed, and this nut engages with a screw 4 inches in diameter fixed to the table. The worm is arranged to drop automatically out of gear and is acted on by a dog set to trip it at any point of the traverse.

Referring to the drawing, Fig. 2, the hand wheel *A* operates a sliding key which gives 4 different feeds. By the operation of clutches *B*, by means of hand-wheel *C*, the other four changes are obtained which are about three times the first, and in order to accomplish this quick change, a special arrangement of clutches is adopted. Owing to the speeds at which the clutches run, it is considered undesirable to use toothed clutches only, and friction clutches of sufficient power being difficult of application in the available space, a combination of the two types is used. The friction clutches *D* are engaged to accelerate without shock the gears in the box, and when the necessary speed is obtained a further movement of the hand-wheel engages the toothed clutches. Two tachometers *E* indicate the speed of the clutches, and on their speeds coinciding the toothed clutches are easily engaged while the machine is running at full speed. The utilization of heavy roughing cuts at comparatively slow speed and light finishing cuts at treble ratio is thus rendered an easy matter.

The heavy bed is 21 feet long; the box-section uprights which are 9 inches on the face, and 3 feet 9 inches deep, are secured to the bed by six 1¼-inch bolts and keys. Suitable covers are provided for the exposed gearing. All the operating handles are placed in front of the machine to facilitate their use by the operator. Hand

and power adjustments in either direction are available in connection with the cross-rail and table, steel scales and pointers also being provided. The machine was guaranteed to remove steel (35 tons tensile strength) at the rate of 24 cubic inches per minute, but on its trial test a cut 22 inches wide by 5/16 inch deep was taken at 6 inches per minute, though this would not be recommended as a general thing.

The maximum distance from table top to center of spindle is 2 feet 8 inches, the minimum 6 inches, the minimum distance from table top to cross rail being 10 inches. The spindle bracket has a horizontal adjustment of 16 inches. The floor space occupied is, for maximum traverse, 10x30 feet, and its approximate weight including motor, 23 British tons. The speeds of the motor are from 430 to 860 revolutions per minute, and its voltage 220.

Manchester, England.

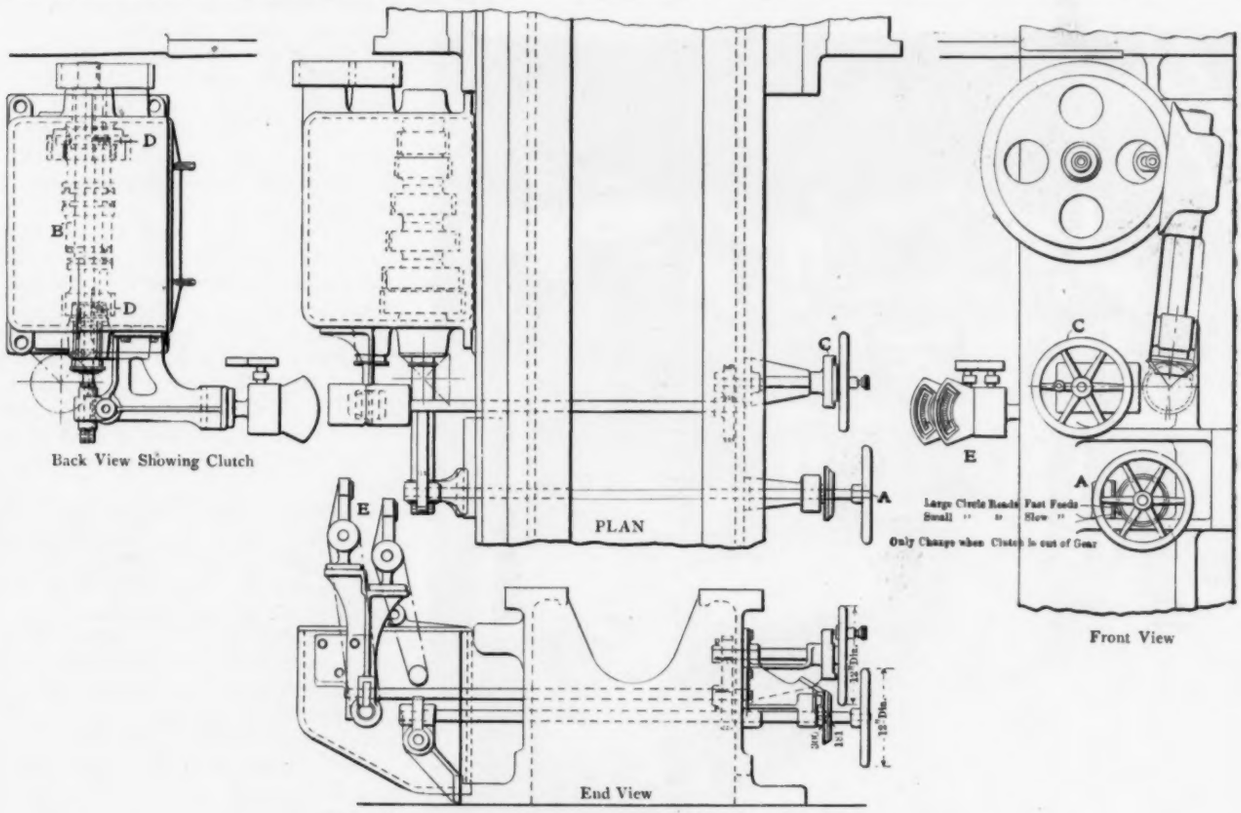


FIG. 2. FEED GEAR AND CLUTCH OF SLAB-MILLING MACHINE.

In making a comparison of steam and electricity for the motive power for driving the fan of a heating apparatus in connection with a blower system of ventilation and heating, the low thermal efficiency of the steam engine may actually be a point in its favor, because, since the steam is required in any case in order to pass through the heating coils, and a comparatively small portion of its heat is abstracted during its passage through the engine, it may therefore be preferable to make use of the steam engine instead of the electric motor.

Engineering Ethics.

BY DR. S. S. WHEELER.*

While I have prepared in writing something of an annual address, as required by the Constitution, I shall try to express the substance of my theme to you directly, because I attach some importance to the emphasis that can be given only in this way. All that I would say has been summarized by Francis Bacon in the preface to his "Maxims of the Law," where he says:

"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto."

I feel that I cannot make a better use of the opportunity afforded me by this occasion to reach electrical engineers and the engineering profession, nor can I do our profession a greater service, than by raising my small voice in support of the principle so admirably stated by Lord Bacon. I will use my opportunity to urge that engineers interest themselves in improving the moral standard or the ethics of the profession and in strengthening their sense of the obligation that binds all engineers to a course that is particularly honorable.

We, as engineers, are accustomed to hearing ourselves referred to as professional men. The habit of calling us professional, though not strictly accurate, does no harm, and by encouraging us to greater care and conscientiousness ought to benefit. The relations between the clergyman, physician, or lawyer and his parishioner or client are regarded by law and usage as especially sacred and inviolable, and the obligation imposed upon the professional man to be faithful to the interests of the client or protégé is equally strong. It is not in my mind to dwell upon these relations or even to attempt to describe them because they are well known and established and the subject has been treated by many great authorities.

My wish is to draw the attention of engineers and others who are engaged for the people in handling the forces of nature and in interpreting its laws, to the propriety and necessity of regarding themselves as in the same category with the strictly professional man. The attitude of the public contributes to this obligation. The public considers (much more than there is reason for) that the several branches of engineering are special subjects and not easily within the comprehension of the layman, and therefore it places itself in the hands of the engineer. He is thus put under the utmost moral and professional obligation. The duty is as great as that of the physician to his patient, although engineers as yet do not generally recognize such responsibility.

On the other hand, the public finds no such declaration of high standards in the

*Presidential address at the 23d annual convention of the American Institute of Electrical Engineers, Milwaukee, Wis., May 28, 1906.

engineering profession as in the older professions. It is therefore inclined to treat the engineer lightly in ethics, and to withhold from him that deference which, if rendered, would in itself encourage a higher professional standard.

That much thought has already been given to the subject by engineers, architects, etc., is shown by the numerous discussions which have taken place in many of the societies. The conclusions reached by many of them, as expressed in the several codes of ethics formally adopted for the guidance of members, are very interesting and helpful. I ask "leave to print" at the close of these remarks, reference to these discussions and codes, with acknowledgment for the valuable assistance of my friend, Edwin Burt Douglas.

In a few cases, however, being prepared principally with a view to the relations of the members of the profession to each other, these codes are rather narrow and in the style of labor-union rules. This suggests that greater weight be given in them to the interests of the client and the interests of the public.

The electrical branch of engineering, being the youngest, has not yet formally taken up the question of ethics, but should do so and will have the aid of the experience of all other branches of the profession.

The moral duties of the engineer may be summarized as follows:

First, the duty to the client. To see that his interests are protected, that he is wisely educated, or advised as to what he ought to have. That he gets it. That information pertaining to him does not reach others.

Second, the duty to the public. To see that the public is not imposed upon by misinformation. The newspapers are full of descriptions of schemes which mislead the public and of wildcat stories that are a reflection on the engineering profession. Engineers are frequently called upon to discuss such schemes and to point out their absurdity; and are frequently unable to convince the layman that they are without merit, because the public mind is not sufficiently educated in engineering matters and because the professional standing of engineers in the community is not high enough.

Third, the duty to the engineering societies, which involves contributing to their welfare, both in time for administration and the preparation of technical contributions and discussions, and in money. There are three reasons for this obligation: First, the society represents the art or craft by which the engineer supports himself. Surely he owes it some debt; second, it is to his advantage that the branch to which he belongs should attain a position of strength and recognition, and that it should command respect for its opinions and indorsements; third, he should so conduct himself as to stand well in his society, whose members are his peers, and are therefore the men whose commendation the world will accept.

THE ENGINEER'S DUTY TO HIS CLIENT.

This is, of course, the most important obligation to be considered, and the one to which all others must give way if there is any conflict. This is the direction in which improvement in the attainment of loftier ideals, which may be expected from natural evolution as time goes on, will be most appreciated by the public, since in this direction the public is most affected. It is hardly necessary to say that the client is entitled to the very best there is in the engineer in thought and in service or execution, and I mention it only to make the statement complete. In drawing a comparison between our profession and the older or recognized ones with a view to selecting the lines along which we should try to guide our evolution and improve our standards, while I believe that the essential principles involved are the same, and that we should set our aim at as high and even a higher standard, there are some considerations which must not be neglected and which necessarily call for the employment of slightly different means in attaining the same end.

Many supposedly independent consulting engineers have affiliations with engineering or manufacturing concerns interested in the introduction and use of a particular apparatus. The engineer usually recommends the same apparatus, and its manufacturer recommends the engineer to clients. It is often held that the best engineers are subject to such affiliations, because the best are sought after, and the absence of such affiliation is an indication of lack of capacity. This is not completely true, and there are many good men doing general work, though not nearly so large a proportion as of general practitioners in law or in medicine. The circumstance, however, imposes upon those who are subject to such relations the obligation to be especially careful when advising a client to acquaint him fully with the fact of such relation and to divest themselves at the moment of any influence which might bias their judgment. Their advice will then have increased value due to their special knowledge and experience.

Another fact which differentiates engineering from other classes of professional work is that study and work for a client takes the shape of drawings and data, which are usually regarded as the property of the engineer and not of the client. Such records are often voluminous, and are an exact statement of the affairs of the client as far as they go. Obviously, the custody of such matter involves important points in the relation of the engineer and the client, and if misused the consequences to the client may be serious. Even when an engineer is on the simple basis of an employee, it is sometimes suggested that sketches and data, such as may be contained in notebooks, are his personal property. In this connection the fact that nearly the entire work of the engineer is reduced to and is represented by drawings and figures, as stated, gives the subject great importance. Perhaps here is the greatest difference between the engineering and the other professions. There is no parallel in the so-called learned professions, and the client or patient, almost without exception, employs aid simply for experience and advice, and at no time does occasion arise for the reduction to a minute record of the preliminary or final results. In this respect moral responsibility devolves upon the engineer in greater degree than upon others. The point may well be illustrated in a more ordinary connection by considering the possibility of a manufacturer, founder or artisan furnishing to strangers articles made from designs, drawings or patterns, the property of others which happen to be in his possession.

Professional relationship between the engineer and client in respect to its confidential nature and its inviolability is not thought to be like that of the physician or lawyer to client or patient, and is not so recognized by law. I believe the courts should recognize it, and in any event the engineer should so regard it as applying to himself, and if anything should be even more scrupulous than the physician or lawyer. In these days most engineering is done for corporations; but while corporations are "artificial" persons, they are, nevertheless, created by the state, and therefore the state has the right to dissolve them, to examine their books, to ask questions, etc.—rights which the state does not possess in the case of individuals. While this difference between the legal rights of corporations (which form the bulk of the clients of engineers) and the legal rights of individuals (who form all of the patients of doctors, all of the charges of clergymen, and many of the clients of lawyers) is not the cause of the difference in the legal status of the engineer's confidential advice compared with the advice of the physician or lawyer, it is yet suggestive of it and thows light upon it. Therefore engineers should be the more careful in regard to matters of confidence.

To the engineer whose work is educational and whose clients are, therefore, his students, is given the opportunity to exercise at once the most direct influence for engineering honor, by his teaching. We may, therefore, expect that the profession will receive its greatest help from him.

THE ENGINEER'S DUTY TO THE PUBLIC

is largely educational or instructive. If the public believes that engineering is a subject it is not fitted by talent or training to deal with, whether it is justified or not in this belief, is not the engineer under the strongest obligation to guide it

aright? When a man trusts you, you are bound to respect the trust, or you will lose your standing. We all know that a mass of misleading, foolish and sometimes deliberately deceptive information on engineering or scientific subjects is given out, circulated and published. All of this by its ultimate failure brings our occupation into disrepute. Many engineers, when asked, reply correctly, pointing out the misstatements and errors but how many of us try to be good teachers? How many of us take care to see that the real facts, the real situation, the real need or the real possibilities are made plain to the layman? Take an ordinary case, such as the almost daily statement that someone has invented a new motor (not necessarily electric), so powerful that trains can be run a hundred or two hundred miles an hour by it. Assume that there are 10,000 engineers in the United States, I suppose that 1000 of these say each time the subject is brought to their attention that it is absurd; that they don't believe it; that it has been tried two or three times but never successfully, etc. How many of even the thousand do you suppose take enough interest in setting the public right, to spend enough time to say that travel at any such speed is entirely a question of roadbed and right of way, that it is easy enough to make motors of almost any kind having power enough to pull a car or train at these speeds, but that practical roadbed conditions prohibit it, and that the most perfect track ever built is so irregular that the train would be liable to jump the track at such a speed. Those who give true educational explanations in form digestible by the laymen do their duty to the public, and do it and their profession a service. It ought to be clear to every engineer, and it probably is, that the more the public is enabled to understand the real facts, the more discriminating an audience it will become for the appreciation of really meritorious feats of engineering. At present I fear that in the public estimation telegraphing to Mars is far ahead of getting the drydock "Dewey" to Manila. When a man who is in a position to know, either as a result of training and education, or of Heaven-sent talents, is asked, by one who does not know, any question about engineering, physics, or the laws of nature, and he does not set that man right to the best of his ability, he is shirking his duty. Possibly he is assuming that he has a patent on some of the laws of nature, or a part interest. This view would not raise him in anyone's estimation.

Another example occurs to me. I have seen a man as a witness in court, after qualifying as a patent expert, which means that he is officially clothed with authority as an engineer, and that he is there for the information of the court, spend hours and even days framing numerous answers to a single question, his sole object being to avoid, if possible, making a simple statement of the truth. The mistake, of course, is that the man confuses his duties and acts as an advocate, while the public understands that he is there as an engineer to make clear the facts. The result is well known and gives rise to the saying, "Liars—liars and patent experts." The example serves my purpose well in illustrating by extremes what I mean when I say that it is the duty of an engineer to give the public the truest and simplest explanation of each engineering question when it comes up in his community, taking care to put it in such form as will be understood.

THE ENGINEER'S DUTY TO HIS PROFESSIONAL SOCIETY.

The other duties of the engineer I have placed before his duty to his professional society, because this latter relates to his solicitude for himself and his fellow engineers as distinguished from his solicitude for his client and for the public. The principle of doing something, however, for "your crowd" is so well established and recognized that it does not need full discussion here. I think even some animals act upon this principle. The institutions of crafts, societies, fraternities, guilds and the like, is very old, and the reasons for them are sound and well known. Yet there are those who pay no attention to the official society representing the profession to which they belong. Rare and peculiar birds.

Unfortunately some societies are at times not well run. The meetings are sometimes monotonous, owing to the presentation of matter which does not happen to relate particularly to or interest the members then present. The groups of men are not well balanced, some being older men with wide experience, while others are the beginners, and sometimes the meeting quarters are not comfortable. None of these things is an excuse. If the profession is young and poor, so are you. If you have prospered you are a member of an important and successful profession, and then, if the quarters are poor and the society not strong, it is your fault, because you have not contributed enough to make a society important in proportion to the position you have attained by work in the sphere of activity which it represents. There are many ways in which you can support, encourage and contribute to the dignity of your professional society, and you can select those means which are most agreeable to your own methods. Even the mere attitude of approval of the society is of great value. It is well to give your profession and the public to understand that you believe in your society and follow its recommendations and standards.

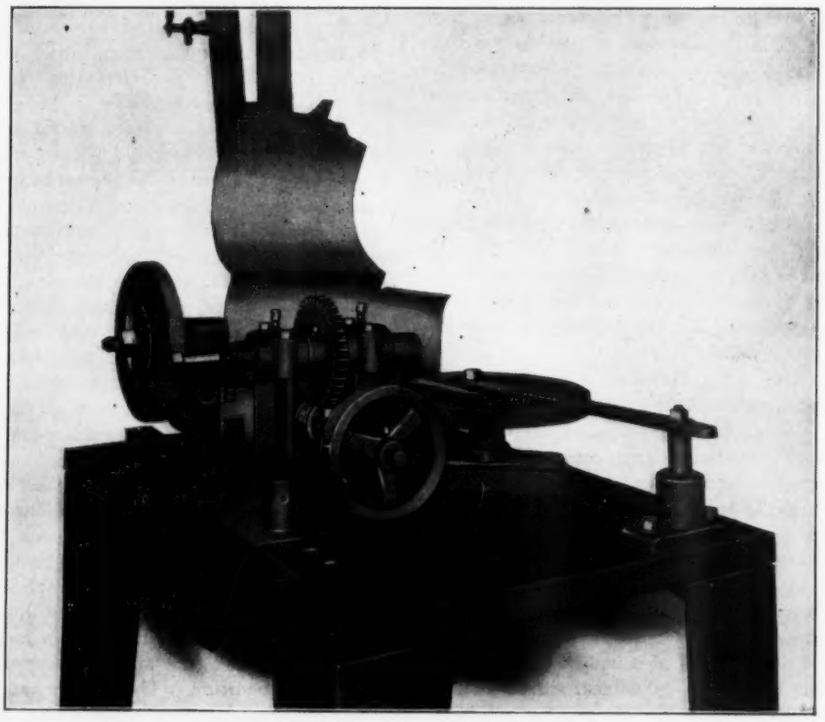


FIG. 1. MACHINE FOR GRINDING FACES OF PULLEYS.

A more commonplace, but none the less positive, reason for your obligation to contribute to the support of your society is that you are earning your living out of the art which it represents and which it is trying to dignify. Your obligation is, therefore, definite. It is also greatly to your interest that your profession be made as important and its position before the world as commanding as possible; and it would not be right were you to allow other professionals to bring about this result without your aid, and then for you to reap any benefit from it.

In conclusion I will mention what I believe to be the broadest and most important function of professional relations—an engineer's standing or the way in which he is regarded by his contemporaries. All the world recognizes that the best judgment of a workman is by other workmen, of a woman by other women, of a lawyer by other lawyers; likewise the best estimate of an engineer as a man and engineer is by the members of his own profession.

A Home-made Pulley Grinder.

The machine shown in the accompanying illustrations has been in use for a considerable time in the shop of William Hollingsworth, Baltimore, Maryland, and was designed by Mr. Hollingsworth to enable the face of a pulley to be given, in the grinding process, a curved crowning, so as to be in form the zone of a spheroid. Fig. 1 is a general view of the machine with a small pulley on the work spindle; not much of the gearing is visible on account of the dust shields. In Fig. 2 the shields have been opened up, and the work and one of the driving belts removed. The position of the gearing which is still hidden in this view, is made clear in the sketch Fig. 3, which consists of plan and elevation of the portion of the machine which carries, and gives motion to, the work. The emery wheel, a portion only of which is shown, is carried on a Builders' Iron Foundry standard 12-inch grinder head, and can be fed toward the work, or withdrawn from it, by means of a hand-wheel on a feed-screw having the same direction as, and not far removed from, the worm shaft shown. The whole machine is mounted on a cast bed-plate *A*, 1½ inches deep, of ½-inch metal, crisscrossed underneath by ribs and supported by gray-iron legs. Near one corner this plate has a number of one-inch holes, into which the pin *B* may be inserted. This serves as a fulcrum for the swinging arm *C*, to which are fastened the parts shown in Fig. 3. *C* has several holes *D D* for the fulcrum pin, so that the radius of the pulley-face curve may be varied as desired. The other fixed point in Fig. 3 is the stud *E*, which is the fulcrum for the lever *F*. *G* is a pulley to be ground, mounted on the work spindle *H*, running in bearings *J* and *K*. The casting of the latter is broken away in the elevation, Fig. 3, in order to make plain the gearing which it straddles. This casting comprises also bearings (not shown) for the short vertical shaft. Upon the spindle *H* is mounted the worm wheel *L*, 36 teeth, 6 diametral pitch, which is driven by the worm *M* on the main driving shaft *N*. *P* is the driving pulley on this shaft. By means of the parts described, the work is slowly rotated while being ground. The interesting part of the machine is the following device for giving the convexity to the face: The worm *M* drives a second worm wheel *Q*, the same diameter as *L*, on a vertical shaft *R*, carrying a pinion *S*, 12 teeth, 12 pitch, meshing with a spur gear *T*, of which different sizes may be used, the one on the machine at the time I saw it having 144 teeth. On the face of this large gear is a crank pin *U*, which works in one end of the lever *F*. It will be seen that as the machine operates, the crank pin *U* rotates and forces the lever *F* to swing to and fro, which necessitates also a swinging motion of the arm *C*, carrying the pulley being ground back and forth in an arc, so that the emery wheel produces a curve as shown as *V*. The driving belt is long enough to allow for the motion of the pulley *P*. The other belt in Fig. 1 is, of course, that which drives the emery wheel spindle.

It is evident that the machine gives a theoretically perfect form of crowning to the pulley-face. H. J. K.

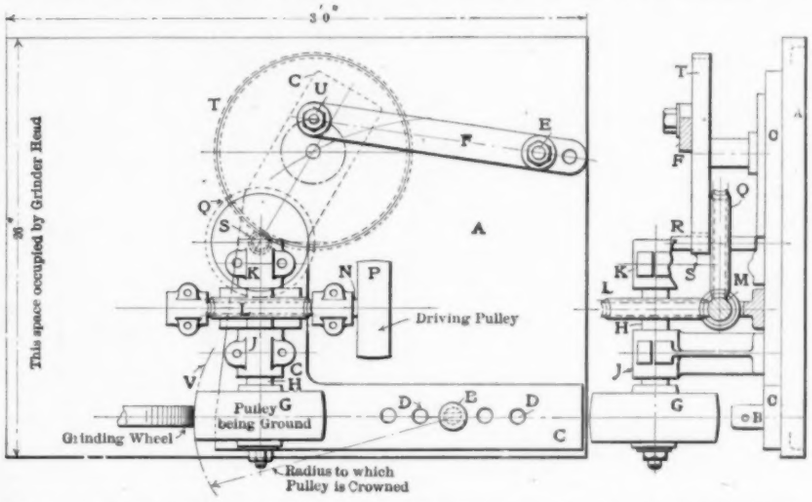


FIG. 3. MECHANISM FOR CARRYING AND ROTATING THE PULLEY, AND SWINGING IT ABOUT A CENTER.

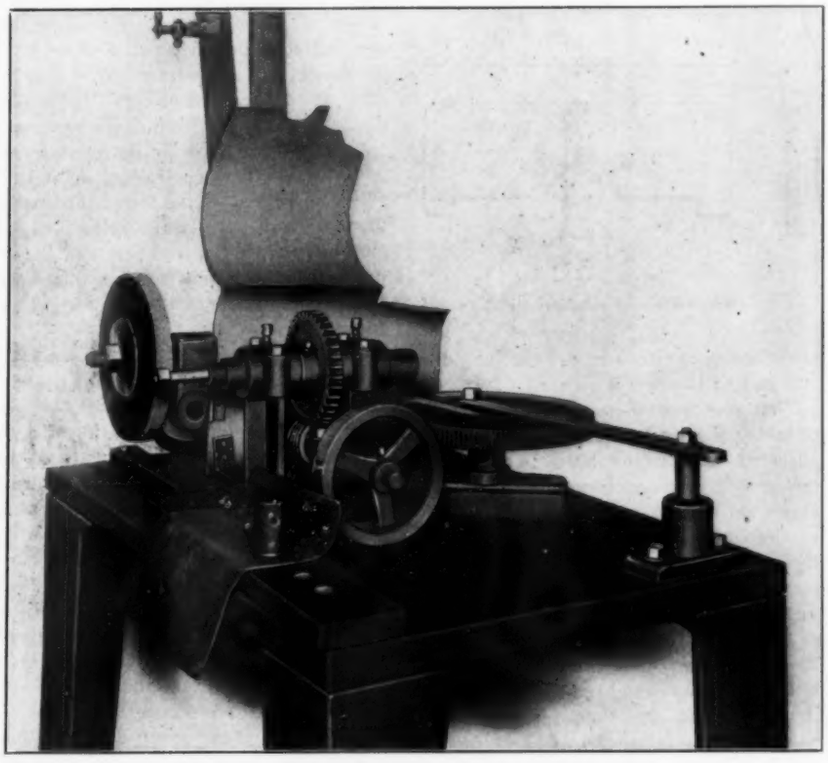


FIG. 2. PULLEY GRINDER WITH DUST GUARDS OPEN.

Some large steamers are now being built to be propelled by Curtis steam turbines. The cruiser "Salem" for the U. S. Navy, is 420 feet long, displacement 3750 tons, designed speed 24 knots, horsepower about 16,000, 350 r.p.m. The Southern Pacific's "Creole," 415 ft. 8 in. long, displacement 10,160 tons, designed speed 16 knots, will require about 8000 h.p., revolutions about 250. Her turbine will be one-half the weight of engines.

Tools for Machining Brass Type-Wheels.

BY EDWARD SNYDER.

The tools shown in the accompanying drawings were constructed at the factory of the International Time Recording Company, Binghamton, N. Y., for the purpose of turning the rims and finishing the holes, shoulders and ends of the hubs of cast-brass type-wheels, and with one exception (the chambering tool) were designed by me.

THE WORK AND THE GAGES.

Fig. 1 shows a few of the different wheels that are finished with these tools: *A* and *B* are 3⅛ inches in diameter with rims 7/32 and ¼-inch face and hubs and shoulders of different lengths. There are four different kinds of these wheels necessitating four sets of gages similar to those in Figs. 2 and 3. *C* and *D* are 2 27/32 inches in diameter, with rims of from ⅛ to 5/32-inch face; there are three varieties of this size each necessitating a separate set of gages. Wheels *E* and *F* are 2 9/16 inches in diameter and their rims are from 0.165 to 9/32 inch wide. As in the preceding cases, the hubs and shoulders vary in diameter and length, and one wheel in particular has an aggregate of five shoulders on the hubs; it requires a double set of gages similar to Figs. 2 and 3, for this type of wheel. There are six arms in each wheel.

The diameters of the hubs are standard sizes and snap gages are used where the shoulders cannot be measured with a micrometer. Cams, sprockets and gears being fastened to or having a bearing on the hubs, the sizes are within close limits on some parts of the wheels. The gages of the Fig. 2 style are used to set the tools approximately for turning the diameter and length of the shoulders, and are of tool-steel hardened. The gages like Fig. 3 for measuring the distance from rim to shoulder and from shoulder to shoulder are made of 3/32-inch ground flat stock and are not hardened. The plugs are the correct sizes for the holes and are hardened on the ends. Each gage is marked with characters corresponding to the wheel it is used for and also to show whether it is for first or second operation. It will be observed that the backs of the gages are flat; they were formed in this way to enable the distances from shoulder to shoulder to be obtained correctly and easily.

SETTING THE WORK FOR THE FIRST OPERATION.

The first operation on the wheels consists in finishing the rims on both edges and the periphery, the shoulders on the outer end of the hub, also the hole, and the chambering of such wheels as are recessed in the center. Fig. 4 is a top and end view of an expanding chuck which is fitted to a Garvin screw machine having a screw for operating the cross slide and a pilot-wheel feed for the turret slide. The cross-slide tools also shown are held in tool-posts similar to those used on the Brown & Sharpe No. 2 wire-feed screw machine. I own up to "pirating" the idea and using this style of tool-post on four different screw machines. A wheel similar to those at *A B* in Fig. 1 is shown in dotted lines on the chuck.

The operations on the wheel during the first setting are as follows: 1st, chuck; 2d, rough with the back tool the outside of the rim and the end and shoulder of the hub; 3d, center; 4th, drill; 5th, straddle-face the rim, also take a light cut again on the periphery; 6th, bore; 7th, chamber the hole; 8th, ream; and 9th,

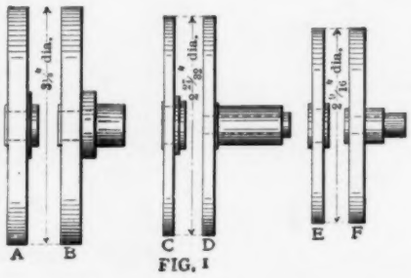


FIG. 1

FIG. 2

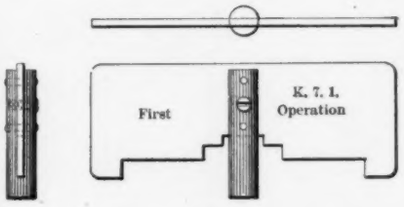


FIG. 3

THE WORK AND THE GAGES.

turn the rim to size, also size the shoulders and end of the hub.

The gray-iron piece at *G* is used in chucking the work, the three screws being adjusted so that the heads will project the proper distance from the face. The chuck is released so that the jaws move in, the wheel to be machined is passed over them, the casting *G* is placed on the centering tool and the turret slide moved forward as far as possible, bringing the heads of the three screws in the casting against the faces of any three of the jaws *H*. The wheel is then brought against face *I* of the gage, and the chuck jaws are expanded. Providing the wheels in the rough are of uniform thickness the edges of the rim will project about the same distance each side of the jaws as shown at *J* Fig. 4, if the screws in *G* are properly adjusted. The mechanism of the chuck will be explained later.

THE CROSS-SLIDE TOOLS.

The roughing tool for the rim and hub, which is held in the rear block on the cross slide has a body forged from machine steel and carries inserted tools of high-speed steel which are held in place by means of three clamps at the underside. Any tool can be removed for grinding without disturbing the others or the setting of the tool proper.

An ordinary centering tool is used, which is made of ⅝-inch drill rod. Two speeds are employed for the spindle; high speed for all the work on the hub and hole and a slow speed when the rim is being worked on. In grinding the drills the corners are not "tipped off" as is ordinarily done when working brass. The spokes of some of the wheels are not very thick and if the drill were "tipped" the pressure required to make it cut would sometimes dish the wheel.

The front tool in the cross slide is made from a machine-steel forging and the inserted tools are of 5/16-drill rod hardened at the cutting end for about ½ inch and held in place by ordinary ¼-inch set-screws. Either straddle tool can be removed for grinding without disturbing the others, but it is necessary to shift both tools when the central tool is removed.

THE TURRET TOOLS.

The boring-tool holder Fig. 5, is made of 1¼-inch round machine steel and the tool is held in place by eight round-end set-screws. The tools are of ½-inch steel, are hardened on the small end as far as the body and then drawn to a blue except at the cutting edge. In making these tools the small taper part is turned and at the end a rib or flange is formed and then filed away, leaving enough for a cutting edge. I have found this method more expeditious than forging the tool and dressing the tapered part and the cutting edge, and cannot see but what a tool made in this manner is just as rigid as a forged one.

The chambering tool in Fig. 6 is clamped in a holder and the handle *K* clears the collar about 1/16 inch when adjusted properly. In operating, the turret slide is moved forward with the tool in the position shown until a line on the saddle matches a line on the turret slide, then the handle at *K* is pressed until it strikes the collar on the holder, the turret slide is moved forward to the stop and the chambering operation is finished. It is not necessary to finish the chamber in the work to any exact dimensions as it is merely a relief in the bore to allow the wheel to rest more firmly on the shaft. This chambering device is very simple, but it accomplishes the purpose admirably. The device for holding the reamer in Fig. 7 is an adaptation of a floating holder described several years ago in the AMERICAN MACHINIST.

Fig. 8 shows two views of the turret tool for finishing the outside of the rim, one end of the hub and also the shoulders on the hub. One tool of this type (used

in another operation) does not have the outer cutter for finishing the rim of the wheels and is extended only as far as the dotted lines at *L*. The body of the tool is a machine-steel forging and slots are provided to receive inserted cutters, similar to the two at an angle in the back tool in Fig. 4. Only one pair of clamps are shown in place. Pieces *M*, *N* and *O* are packing strips and are standard widths of cold-drawn steel. The tools or cutters are ground to 5/16 inch square; the different slots they are held in are standard widths, i.e., 5/16, 5/8 and 7/8 inch, and by means of a few tools ground to different widths at the cutting edge and different packing strips a large number of combinations can be made for finishing diameters and lengths of shoulders on the hubs.

the size of the hole in the wheels being finished, no bushing being used in the expanding plunger larger than 3/8 inch.

SECOND-OPERATION TOOLS.

The wheels *A*, *B*, *C* and *D*, Fig. 1, are finished on the back side of the hub with a facing tool, but the wheels *E* and *F* have to be put in the chuck Fig. 9, to have their hubs and shoulders machined. This chuck is of gray iron, is slotted at three points, and closed on the wheels by means of a screw carried in the machine steel clamp ring. The latter is held in place by the end of the set-screw fitting in a depression in the chuck and by two small headless screws which pass through the ring and whose points fit loosely in holes in the chuck body. The rectangular lug at one side of the ring is a counter-

turning, recessing, etc.; were made facsimiles of the screw-machine spindle nose.

A TOOL-GRINDING FIXTURE.

Fig. 10 shows a fixture for a small tool grinder used in sharpening the cutters inserted at an angle of 60 degrees in the back cross-slide tool in Fig. 4 and also in the turret tool, Fig. 8. The pedestal or socket *S* is fast to a slide and by means of the key at *T* and the binding screw the fixture is rigidly held. The gray-iron block *U* is free to slide on rod *V*, but is prevented from turning by the feather *W* which is held by two screws in a slot that is cut in the underside of the rod to prevent so far as possible emery working in.

When the fixture is clamped in the socket the curve of the emery wheel gives

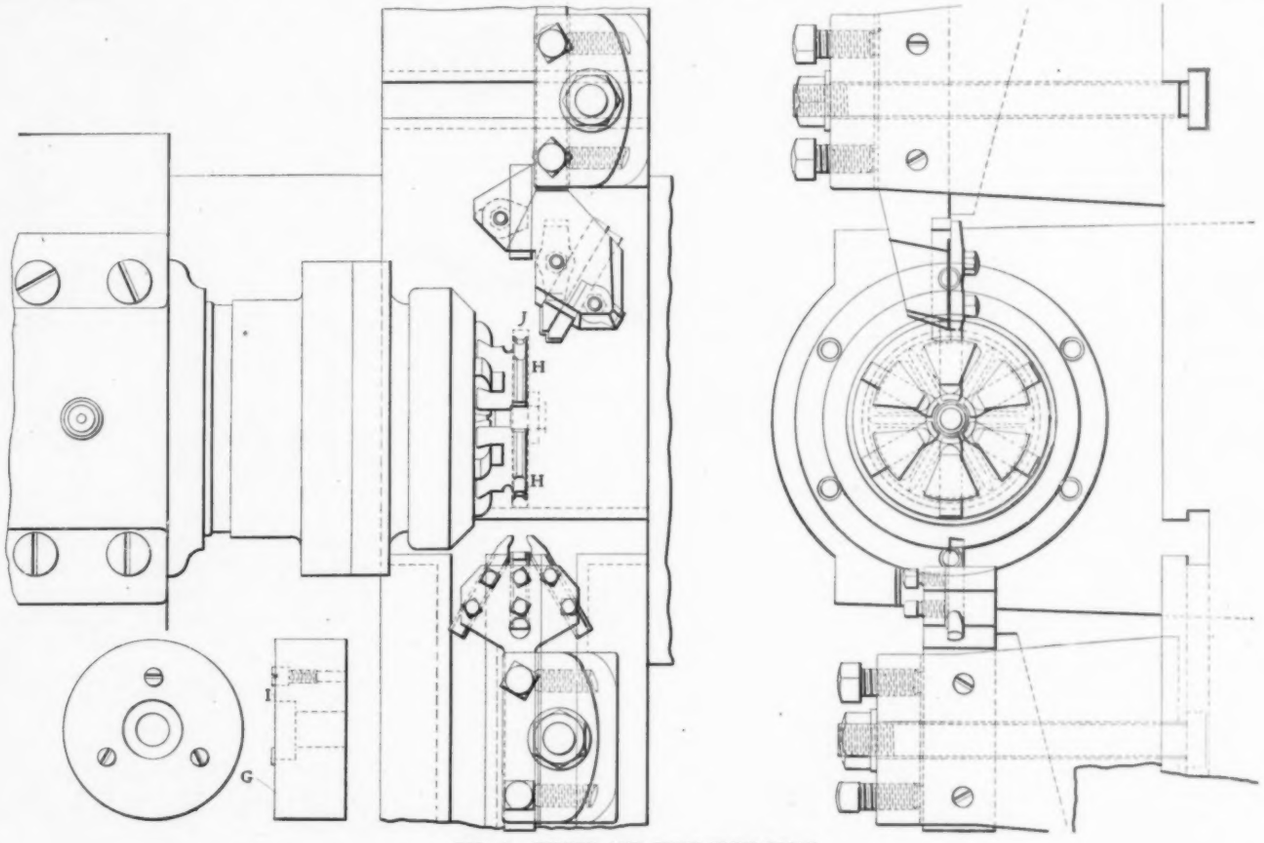


FIG. 4. CHUCK AND CROSS-SLIDE TOOLS.

The point of the tool which finishes the end of the hub enters a depression in the hardened pilot. This prevents leaving a fin around the edge of the hole in the wheel. It is also somewhat easier to obtain the proper distance between the shoulder and the end of the hub, if the diameter measurement is not changed by moving the tool *P* a small distance in or out. The tool *Q* finishes the cut on the rim before the hub-finishing tools reach their cut, and the hardened pilot *R* passes through the hole in the wheel and into a hardened bushing in the expanding plunger in the spindle before any of the tools begin to cut. Different sizes of pilots and bushings are used according to

balance for the large screw and its boss. The depression or seat for the work was finished with the chuck in place on the screw-machine spindle, about 1/64 inch of stock being removed with the clamp screw set up lightly. A tool like Fig. 8 extending only to the dottted line *L* is used with this chuck, it not being practicable to use the full length affair that turns the periphery of the work.

In making the chucks for this work two special adapters were used for mounting them on the engine lathe. These adapters were threaded at the rear on the inside a good close fit for the nose of the lathe spindle, while the external parts to receive the chucks while

the correct clearance to the tool. The two slots in the top of block *U* are at angles of 30 and 60 degrees respectively to the line of travel of the block. The tools to be ground are held in these slots by means of a thumb-screw and washer, not shown. The block is passed back and forth, being advanced to the wheel by means of the slide, of which the holder *S* is a part.

THE EXPANDING CHUCK.

The chuck represented on the machine-spindle in Fig. 4, is shown fully in Fig. 11. The main body of the chuck consists of two parts *A* and *B*, which are gray-iron castings, held together with six screws; part *B* also has a hub fitting a recess in *A*

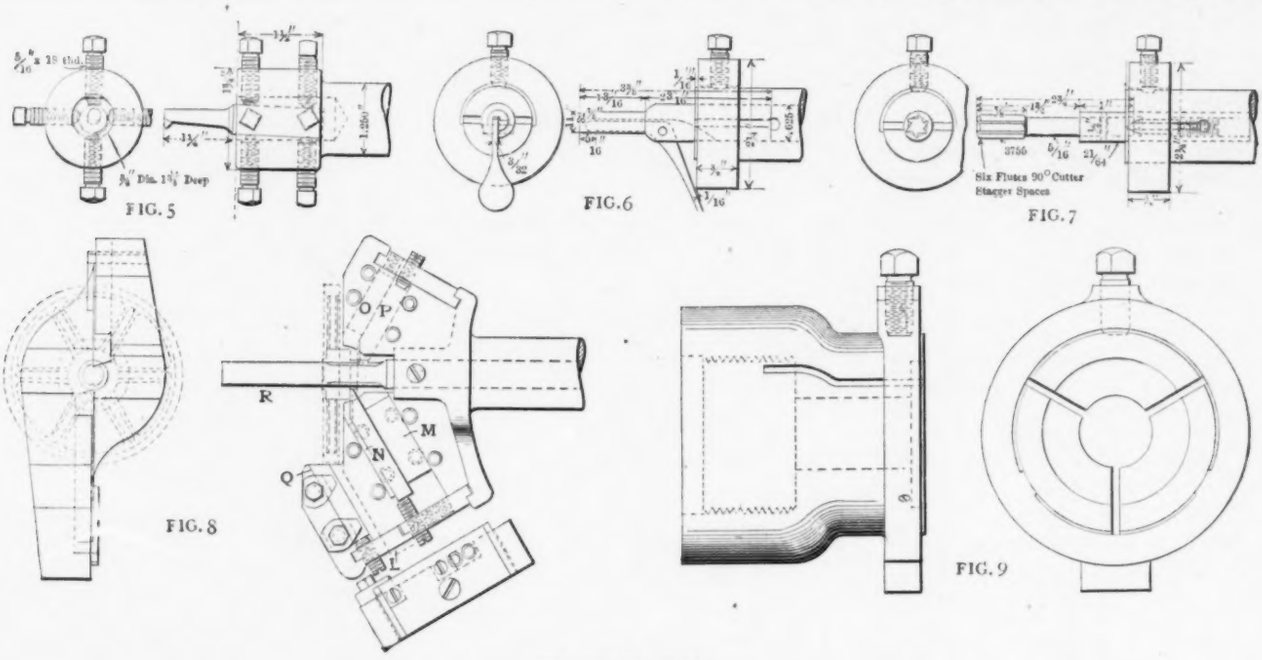
and is threaded at its front end for cap *C*. The chuck was made in this fashion so that it could be used on different sizes of machines by simply changing plate *A* and the expanding tube or plunger *D*. At *E* is indicated the end of a sleeve (attached to tube *D* by pin *F*) which is commonly used to close the split chucks in screw machines by pushing against a hardened steel sleeve or bushing fitting the spindle at points *G* and *H*. Gray-iron cap *C* holds in place the retaining ring *I* for springs *J* and also serves as a cover for the *T*-slots in which slide the jaw-holders *K*. Ring *I* is of machine steel 5/16x⅛ inch in section and 3½ inches inside diameter, and acts as a backing for the six springs *J* which force the jaw-holders toward the center of the chuck, thereby releasing the work when the expanding plunger *D* is moved back. The latter is a close working fit in the body of the chuck at *L*, consequently when it is pushed ahead all six of the jaw-holders *K* move out an equal amount. The conical end of *D* is hardened as is also the inner end of each jaw-holder at the line *a* - *b*, Fig. 12.

M Fig. 11 is a hardened steel bushing to receive the pilots on the turret turning tools. It is a drive fit in its seat, and is further prevented from turning by means of a pin. The holes in the several bushings used are lapped about 0.00025 inch larger than the hardened pilots which they support.

At *N* is shown one of the styles of jaws used for the type-wheels and details are given in Fig. 13. Of course the jaws vary somewhat for the different wheels.

All of the jaws are hardened at the point *c* -*d* not only to prevent wear but to prevent their destruction through carelessness in setting the straddle tools which face the rims of the wheels. The reason the screw *O* is not placed head out is that it was the intention to finish a wheel about 1¾ inches in diameter with this same chuck, and therefore there would be left practically no surface on the jaws for holding the work.

The upper part of the joint between the jaw and holder being at an angle relieves the holding screw of part of the strain when the jaws are expanded. The jaws have a radial movement of about 1/16 inch and can be adjusted about ⅛ inch by regulating the position of the sleeve *E*, as is done with split-chuck work when there is a variation in the size of the stock.



THE TURRET TOOLS.

HOW THE CHUCK WAS MADE.

Fig. 14 shows two views of the main part of the chuck and the dotted lines on the outside of part *B* show the outline to which the flange on this casting was machined after the taper hole and bearing at *L* were finished. The casting was placed on the special mandrel in Fig. 15 and six slots were milled in the periphery to the same width as the slots in the milling-machine table; then the mandrel was removed and the casting was clamped with face *P* against the miller table, with two tongues fitting in two of the milled slots and projecting down into a slot in the table. Roughing cuts were then milled through the face of the casting where the six T-slots were to be, with a cutter milling to 0.370 inch in width and 0.490 inch in depth, care being taken that the slots should be centrally located.

Cutter No. 1, Fig. 16, was then brought into use to further remove the stock. This cutter was used in the vertical spindle attachment, and as the plain part above the threaded end which receives the cutter was hardened and made to fit the slot first milled, no difficulty was experienced in keeping the second milling in line with the first cut. A blast of air at about 10 pounds pressure was kept on the cutter to keep it cool and free from chips. The final milling was done with cutter No. 2, Fig. 16, and, as will be seen from the dimensions given, there was just enough stock left

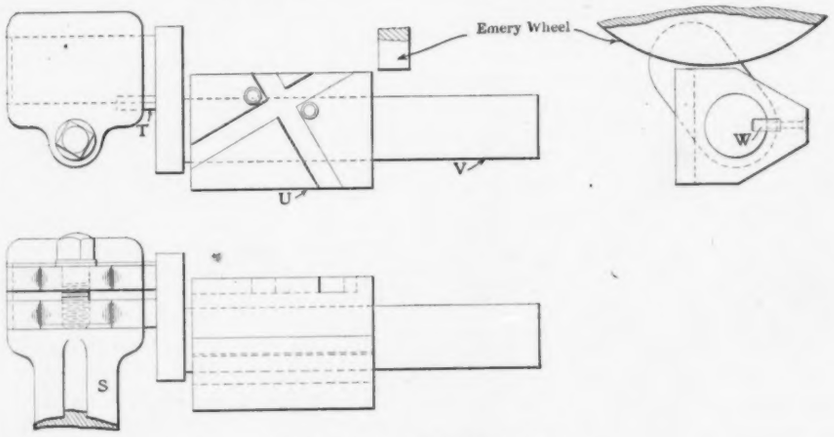


FIG. 10. TOOL-GRINDING FIXTURE.

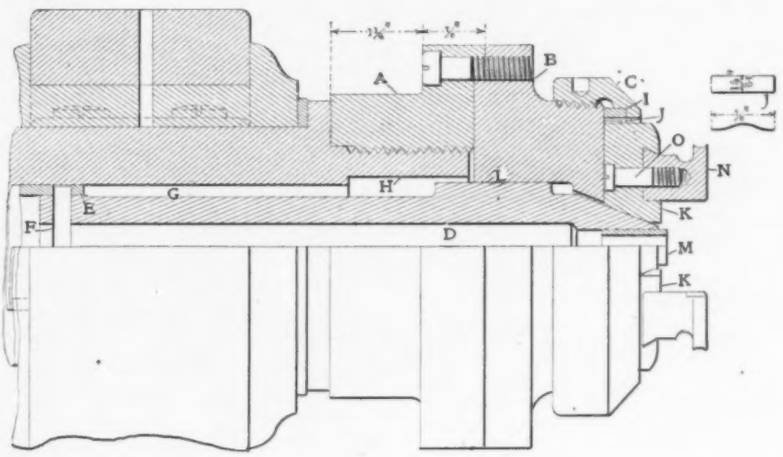
by this cutter to allow the slots to be finished nicely by scraping to ⅜ by ⅝ by ¼ inch. The recesses at *Q* were cut with a small end mill for the springs *J*, Fig. 11, to lie in. The chuck was turned to size on the outside and threaded after it was mounted on the plate *A*.

CHUCK JAW HOLDERS.

The jaw-holders and jaws were planed in lengths long enough to make eight blanks each, and in machining the jaw-holders the chuck and bushing, Fig. 17, were used to advantage. This chuck was originally made for holding punch blocks by the shank while they were turned, milled, planed or drilled. It can be easily clamped to the table of a machine or to the face plate of a lathe by means of the flanged base or by tapped holes, and by using the four slots in the periphery of the flange a punch can be machined on all four sides to within very close limits. The bore was finished to 2½ inches diameter with the chuck in place on the lathe spindle and after the three slots were milled.

The bushing was designed to hold a smaller size of punch block and has a short key to prevent it turning in its seat or dropping when the chuck is clamped to a machine table. This key also fits a slot in the shank of the tool at Fig. 18, which was used to hold the jaw-holder (shown by dotted line) while the inside tapered bearing surface *R* for the expanding rod was being bored, and also while finishing the openings in which the jaws were held. This holder is a gray-iron punch block which was turned up on centers, then milled on the index centers so as to bring the sides *TT* equally distant from the center of the shank. It was then placed in the chuck, Fig. 17, and the slot was milled across the face, care being exercised to keep the edges of the slot equidistant from the sides *T*.

The blanks for the jaw-holders, after cutting from the long planed strip, were square at one end and finished as at *U*. The chuck was screwed on the spindle of an engine lathe having a compound rest and the bushing placed therein; with the end *U* of the jaw-holder gaging against a stop pin *V* and the four fillister head screws clamping the jaw-holder in place, the taper surface at *R* was finished. The eight pieces into which the strip was cut were first roughed out, leaving about 0.005 inch for a finish cut. Then this cut was taken on all eight pieces without changing the position of the tool radially. Next the chuck was clamped on the mill-



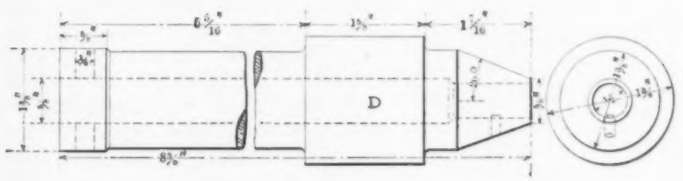


FIG. 11

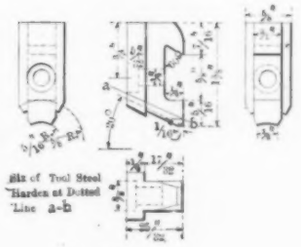


FIG. 12

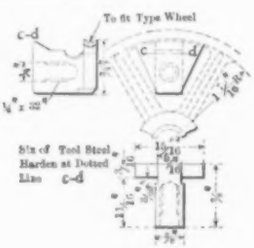
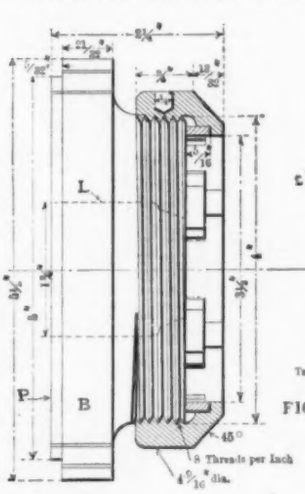


FIG. 13

SHOWING CONSTRUCTION OF CHUCK.



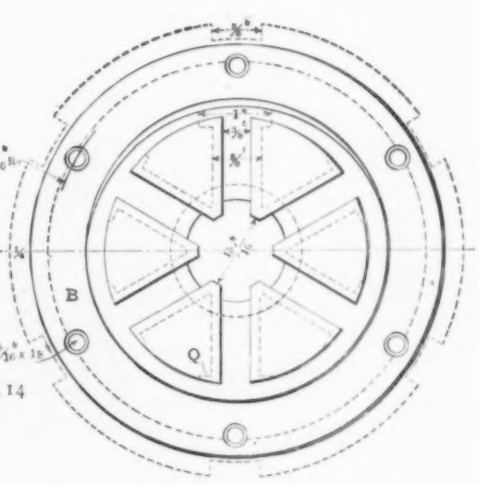


FIG. 14

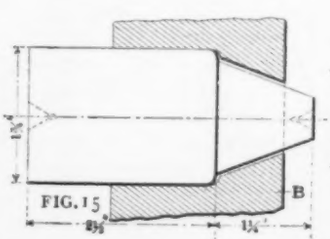


FIG. 15

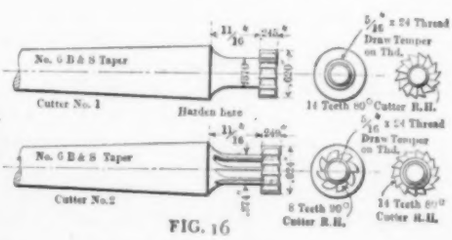


FIG. 16

TOOLS FOR CUTTING T-SLOTS IN CHUCKS.

ing-machine bed and the opening at *S* was milled, the straight surface being finished with a side mill slightly rounded on the corner, while the angular cut was made with a 60-degree end mill used in the vertical milling head. Then a hardened tool-steel block was forced through the milled slots to make them of a uniform size. This block was also used as a jig for drilling the hole for the screw *O* (Fig. 11), the hole being counterbored afterward. The jaw-holders were next beveled on the sides at the inner end, after which they were hardened by heating in a pot of lead to about the line *a b*, Fig. 12, then dipping. The temper was not drawn, for the extreme sharp corner of the taper bearing having been relieved, as shown, there was no danger of its chipping off.

FIXTURE FOR GRINDING JAW-HOLDERS.

They were finished on a Brown & Sharpe surface grinder, the 5/8-inch flat surface at the back being ground first. They were held in the vise for this first grinding operation and finished on the small fixture shown at Fig. 19. The surfaces *a* and *b* of this fixture were trued up after the device was fastened to the grinder. Then one of the jaw-holders was placed in position as indicated by the dotted lines with the surface already ground held firmly against the surface *a* by means of the bolt *c*. The distance *d* from the edge of the base to the narrow part was obtained by means of the graduations on the elevating hand wheel. These surfaces and also the 1/8-inch surfaces at *e* were roughed to within 0.001 inch of size and then finished with a hard wheel having a sharp corner. The jaw-holders were last of all stoned into their respective slots.

FINISHING THE JAWS.

Fig. 20 shows the plug which was used to keep the jaw-holders rigid in their chuck Fig. 11, when finishing the jaws on the circular edge where they grip the inside of the rim of the type wheel. This plug was made from the mandrel in Fig. 15, the large end being cut off even with the back of the chuck, and the front end also being cut off and a hole drilled and tapped at the center for a 3/8 screw. The diameter of the body was at the same time slightly reduced in size so as to be a working fit in the chuck. The six springs *J* Fig. 11 were removed from the chuck and six packing strips were inserted in their places. The screw in the center of the plug Fig. 20, was then tightened, drawing the plug forward and clamping the jaw-holders firmly, the washer under the screw head bearing on the flat surfaces of the jaw-holders when the screw was set up.

With the aid of this device the periphery of the jaws was finished, the groove being somewhat of a loose fit sideways on the inside of the rim of the wheel. This was found necessary as some of the castings were not exactly true in the rim and in such cases if the wheels were brought into a straight line and machined, upon being released from the chuck they would partially resume their former shape.

ACCURACY OF WORK AND SPEED OF PRODUCTION.

Some doubt was entertained by me when I designed the chuck about the wheels being round after they were removed from the jaws, but a difference of no more than 0.0015 inch was detected in the diameter of the rims measuring directly over the spokes and also midway of them, and on a large percentage there is no difference.

On a test of some high-speed steel used in the turret tools shown at Fig. 8, 1895 wheels of types *A* and *B*, Fig. 1 were machined, in one lot. When the tool which finishes the rim was first adjusted the wheel measured 0.001 inch less than the 3 1/8 inch diameter called for or, in other words, was turned to 3.124 inches. When the last of the lot were measured they were 0.0005 large or 3.1255 diameter showing that in turning nearly 2000 pieces the tool had worn but 0.00075 inch.

This lot of wheels was finished in ninety-five hours and eleven minutes according to the cards from the time register. This time included setting up the machine, changing the facing and hub tools for the four different styles of wheels of this diameter included in the test, cleaning the machine when the job was finished, and grinding all of the tools used before they were turned into the tool-room.

By a little calculation it will be ascertained that the time was about three minutes for each wheel; as an actual fact after the tools were set the operator turned out from 225 to 240 per day of ten hours. This was not considered very bad as by the methods used previously the production had been from 25 to 40 wheels per day with no two alike.

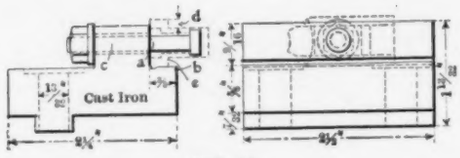


FIG. 19

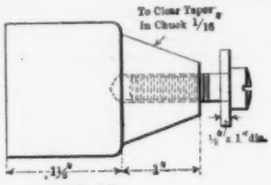


FIG. 20

A GRINDING FIXTURE AND A FINISHING PLUG.

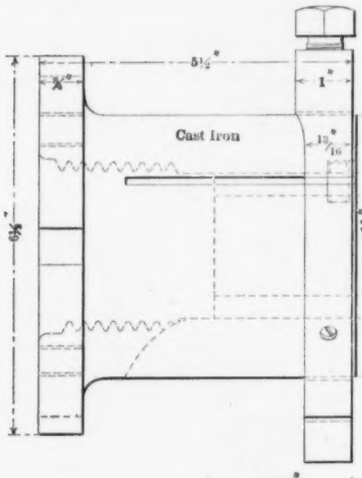


FIG. 17

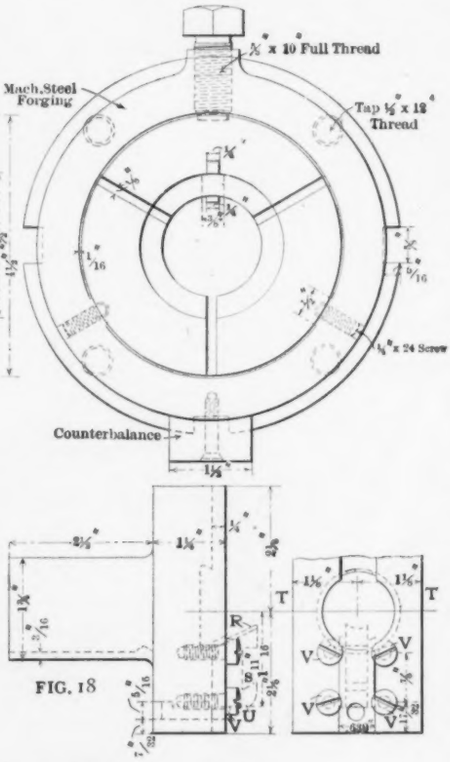


FIG. 18

TOOLS FOR MACHINING CHUCK-JAW HOLDERS.

The German Society of Mechanical Engineers offers a prize of 6000 marks for an effective working-out of a scheme for two-story cars for the Berlin elevated railroad, the upper story to be entered from special station platforms. The necessity for this arises because of through trains which pass through the city over the same tracks and interfere with the urban traffic, which requires more trains than can be put on the road.

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What is Going on in Some of the Shops of the Middle West—III.*

In Cleveland the tool-building shops were found to be at least as busy as in Cincinnati. The first establishment visited, that of the Acme Machinery Company, was in process of enlargement, with the view of just about doubling its capacity. The machines built by this company, chiefly for performing various forging operations, and known as heading machines, have not only increased in size enormously, but the number called for has increased to such an extent as to make this enlargement necessary. They are now able to make about one of these large machines in two days. The addition will enable them to make one a day, besides their other and smaller work.

In the shop I noticed a 20-ton steel casting, which constitutes the frame of a heading machine to go to Milan, Italy. In this tremendous machine the plunger will be able to exert a pressure of 100 tons, and the gripping force applied to the dies may be as high as 65 tons. The design of most of their machines is such that the frames may be either of gray iron or of steel, made from the same pattern; whether the one material is used or the other depends upon the service the machine is intended for.

The foreign trade of this company has increased in a very gratifying way, and among the recent orders was one in which a customer on the Continent had sent a very considerable remittance with an order to build a machine for certain work, of which he sent samples, supposing that it would have to be a special machine designed for the purpose. As it happened, however, his work could be done in a machine which is a regular product of the company, and they were therefore able to return most of his remittance, and he will get a machine to do the work just the same. Such incidents naturally have a strong tendency to stimulate foreign trade, and it is probable that this trade will continue to increase.

*Continued from page 797.

Business in the making of die-heads for threading bolts has also grown enormously, and the work of making the threading dies alone occupies a very respectable amount of floor space, they having on hand at the time of my visit 150 tons of steel for this purpose alone. As Mr. Carpenter expressed it, their success with this die-head has been largely because they have avoided what one of his friends calls a lot of "⅜ and ¼-inch calamity" in its constrruction.

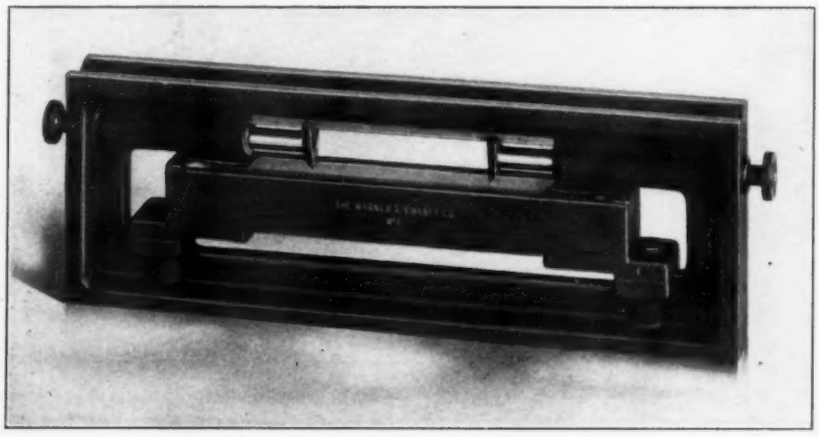


FIG. 1. PRECISION LEVEL BY WARNER AND SWASEY.

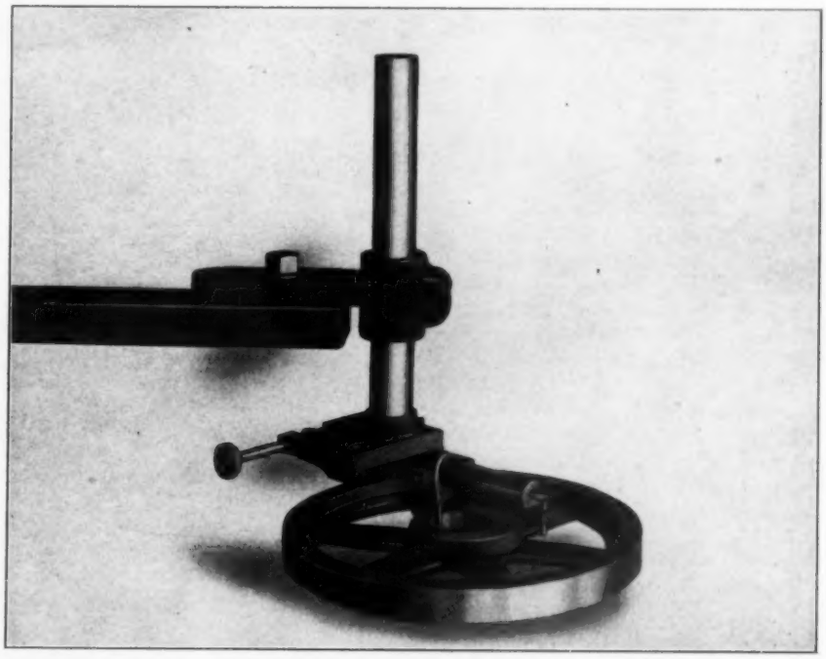


FIG. 2. TRUING BY A LEVEL.

WARNER & SWASEY COMPANY.

The above-named company also has extensive building operations under way, which when completed will result in practically an entirely new plant. At present large additional space is being secured by a new and very handsome shop building which is being erected west of the present building and facing on the same street. In this new building the new offices of the company and the drafting room, as well as considerable shop space, will be located, while back of it new buildings are also being erected. When these are finished it is the intention to replace most of the older buildings as well.

The new shop is evidently designed and built with the idea that the builder of an industrial establishment owes something to the city in which his business is carried on, and should give some attention to beautifying it, if he is able to do so. Warner & Swasey are able and are doing it in a manner which is somewhat remarkable. We hope to be able to illustrate and describe their new shop in due course.

USE OF PRECISION LEVELS IN THE SHOP.

In numerous ways the shop practice of the Warner & Swasey Company shows the effect of their experience with astronomical and engineering instrument making, but perhaps in none more than in their use of refined levels and in their belief in their great utility. The illustration, Fig. 1, shows a form of level recently made by them, which possesses a new feature, by means of which, instead of its being necessary to provide vertical adjustment for the level bulb, within the frame, at one end, in order to make the zero point of the level read correctly when the frame rests upon a level surface, they in effect move the zero point from right to left, or *vice versa*, by means of the movable pointers, shown within the frame and above the glass; these may be placed at a distance apart equal to the length of the bubble if desired and the space between them may be shifted bodily to the right or left, so as to make the level read correctly when resting on a level surface and without the necessity of disturbing the adjustment of the level itself within

the frame. This proves to be very convenient; the adjustment may be perfected at any time, when for any reason it is disturbed, and with these very delicate levels it is difficult to secure exact adjustment by the ordinary means.

The level glass itself has in this case no graduations upon it direct, but is inclosed within the rectangular box shown, which box is provided with a glass cover on both sides. On these glass covers are placed the graduations by means of which the level is read. This is in accordance with latest practice in fine level making, and it is worthy of note that the Warner & Swasey Company believe in and use really fine levels for testing machine parts and for facilitating the setting of work in position when great accuracy is desired.

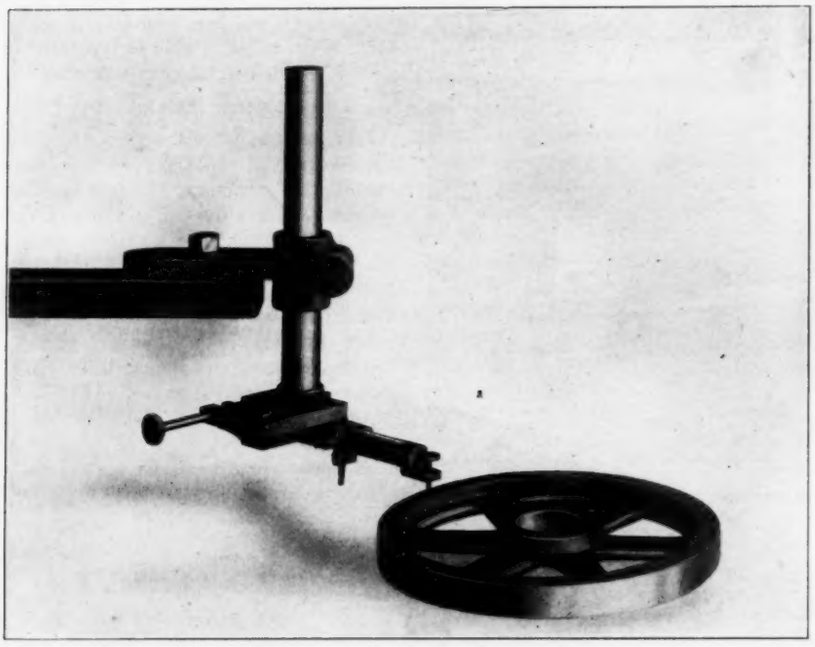


FIG. 3. TRUING SIDEWISE BY PRECISION LEVEL.

These fine levels are made barrel shape inside, the tube being ground inside so as to be somewhat larger in diameter in the center; the radius of this curvature determining the degree of precision and the value of the level. And as the curvature is produced by grinding, and is the same around the circumference of the bulb, the latter may be placed in any position within the tube without altering its value; that is, the graduations will always mean the same.

The divisions on levels, or on the scales used in connection with them, in this country are generally 10 to the inch, and a level is known by the angular value of one division; that is to say, the arc through which the level must be inclined in order to move the bubble from one division to the next. And levels are thus called 1-minute, 30-second, or 10-second levels, etc., as the case may be, which means that when the given level is inclined so as to rotate it through an arc of 1 minute, of 30 seconds, or of 10 seconds, respectively, the bubble will move from one graduation line to the next; or, in the case given above, 1/10 of an inch. The radius of curvature of a 1-minute level is 29 feet, of a 30-second level 57 feet, and of a 10-second level nearly 172 feet. If a 10-second level is mounted on a straight edge, or within a frame 12 inches long, one end would have to be elevated only 0.00058 inch to move the bubble one division, while the 1-minute level, 12 inches long, would be elevated 0.0035 inch for one division.

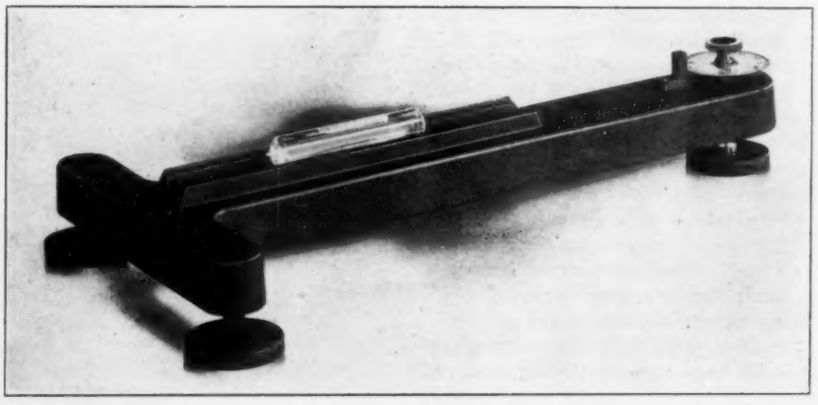


FIG. 4. LEVEL-GLASS TESTER.

It is obviously best to use as fine a level as the nature of the work calls for; and, for instance, if in leveling a line shaft 150 feet long we use a 1-minute level and set to within one-half a division of that level, the shaft will be either 30 seconds too high or too low at one end, which in 100 feet equals ¼ of an inch; while, if we use a 10-second level and set to within one division, the shaft would be a little less than 1/10 of an inch too high or too low at one end, and of course it is easy to set within half a division if the level stands upon a stable base. In leveling and maintaining the accurate alinement of planing machines, fine levels have proven to be well-nigh indispensable and have proven their ability to save money in cost of scraping and working up the surfaces produced by planing. Good levels have been proved to afford by far the quickest method of accurately setting planing machines and of keeping them in condition to do work of the highest accuracy.

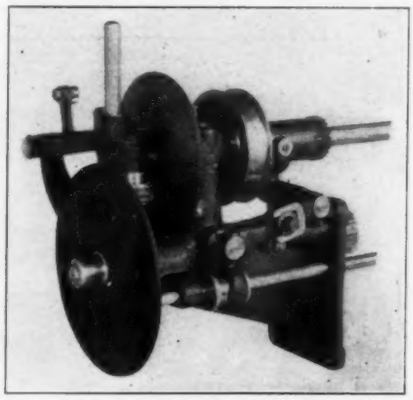


FIG. 5. FEED BRACKET COMPLETE, CLEVELAND AUTOMATIC.

Another class of operations for which levels are much used in the Warner & Swasey shops is illustrated by Figs. 2 and 3, which show, respectively, a method of centering and of truing sidewise a wheel which it may be supposed is to be graduated, or which for any reason it is necessary to set with great accuracy. In this the level is supported adjustably in the manner shown, and as in Fig. 2, where it is used for centering, a contact point attached to the level is so arranged as to bear upon the surface of the bore of the wheel, so that when the wheel is rotated if the bore is not exactly true, it will alternately elevate and depress the level accordingly; and the movement of the bubble will thus show any lack of exact centering. When the bubble of a fine level stands still while the wheel is rotated it is safe to say that the wheel is true.

Of course, with the ordinary level, such as builders use and with which most people are familiar, this would be a very unreliable way of accurately centering such work; but with such fine levels as are under consideration it is thus possible to quickly and surely center a piece of work with the utmost exactitude. In fact, Mr. Swasey remarked that, with a fine-ground

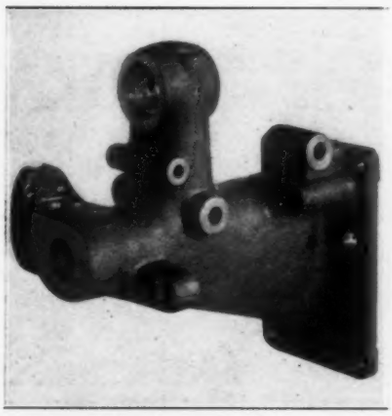


FIG. 6. FEED BRACKET FRAME.

level used in this way, it was easily possible to detect when the wheel was slightly out of true sidewise, because when applied as in Fig. 2 a wheel not quite true laterally would indicate as though the bore were oval in shape instead of round, whereas, having a really round hole in it, when it is trued laterally, and also trued radially, no movement of the bubble is perceptible. For convenience, however, in truing work laterally the same level has a contact point, applied as in Fig. 3, by means of which the lateral truing is quickly and conveniently done. It will be understood, of course, that the support for the levels is in these cases attached to a stationary part of the machine, while the work is placed upon the rotating table.

Such a level as is illustrated may be used in connection with an accurate square for setting a planed surface vertical upon a level planer bed, so that a surface to be planed will be precisely square with the vertical surface, or for setting work accurately upon the level platen of a milling machine, or of a drill press. They enable accurate setting to be done probably more quickly than by any other method, and the degree of accuracy to be secured in this way may be as high as may be desired, depending only upon the quality of the level and the care with which it is used.

Of course it is not meant to say that the company named has devised this method of using levels. It has long been practiced in instrument-making shops but deserves to be better known and understood in machine shops.

The bulbs of such levels as we here speak of are tested in the Warner & Swasey shop, by means of the level tester shown at Fig. 4, which consists simply of the T-shaped frame shown, on top of which is a V, within which the level glass to be tested is placed. At the end of the long arm is an elevating screw having a graduated disk attached to it which is

FIG. 7. JIG FOR DRILLING, BORING, FACING, ETC., THE FEED BRACKET.

made to indicate by its rotation, the angular movement of the frame within the short distance required for a test of this kind. In this way it can be readily proved whether a given level is true throughout its range, and all levels used in in-

FIG. 8. ASSEMBLING FLOOR CLEVELAND AUTOMATIC MACHINE COMPANY.

strument making and about the shop in the Warner & Swasey establishment (most of which levels are imported, by the way) are tested in this manner.

Those machine constructors who have not given this matter attention, and whose aim it is to turn out accurate work and at the lowest possible cost would do well to look into this matter. It is capable of quite varied application, and is not, as one might suppose, a means of spending an inordinate time in securing useless refinement, but will usually actually enable a given degree of accuracy to be attained more quickly than it can be done by any other method, and the advantage of the level increases as the degree of accuracy required rises.

THE CLEVELAND AUTOMATIC MACHINE CO.

The Cleveland Automatic Machine Company was found to be exceedingly busy and was making quotations generally, or at least on most sizes of their machines, at 12 months delivery, the time of delivery being gradually extended instead of shortened, as it was the most strenuous object of the shop to attain.

As in other lines of work, not only has the number of automatic machines called for greatly increased of late, but also the average size of these machines has very much increased, and they are regularly building them now to handle stock up to bars 6 inches diameter, which are passed through the spindle of their largest machine, and worked up automatically. Such a machine has a main bearing for the spindle which is 9 inches diameter by 9 inches long; although owing to the peculiar design of the Cleveland machine this 6-inch machine is not as large as would be expected by comparing, for instance, two lathes, the one intended for work up to, say, an inch in diameter, and the other suitable for work 6 inches diameter.

Among the most notable features of the shop practice here is the very large use of milling machines, and of grinders. Everything that can be finished by milling is so finished; comparatively little planing being done, and grinding is resorted to for finishing cylindrical work to a very unusual extent, for not only are spindles, shafts, and such things that are commonly ground, thus finished here, but cam

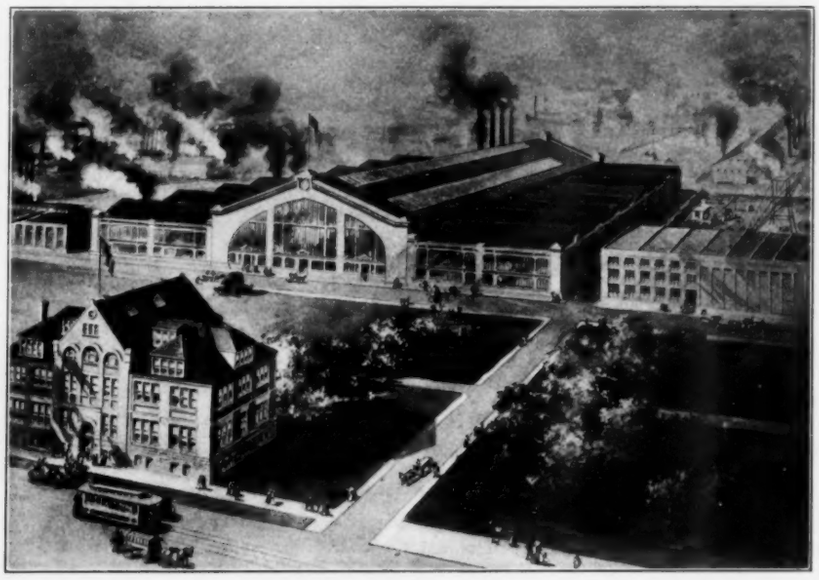


FIG. 10. GENERAL VIEW OF WORKS OF THE BROWN HOISTING MACHINERY COMPANY, CLEVELAND, OHIO. STEEL SKELETON, WITH FERROINCLAVE.

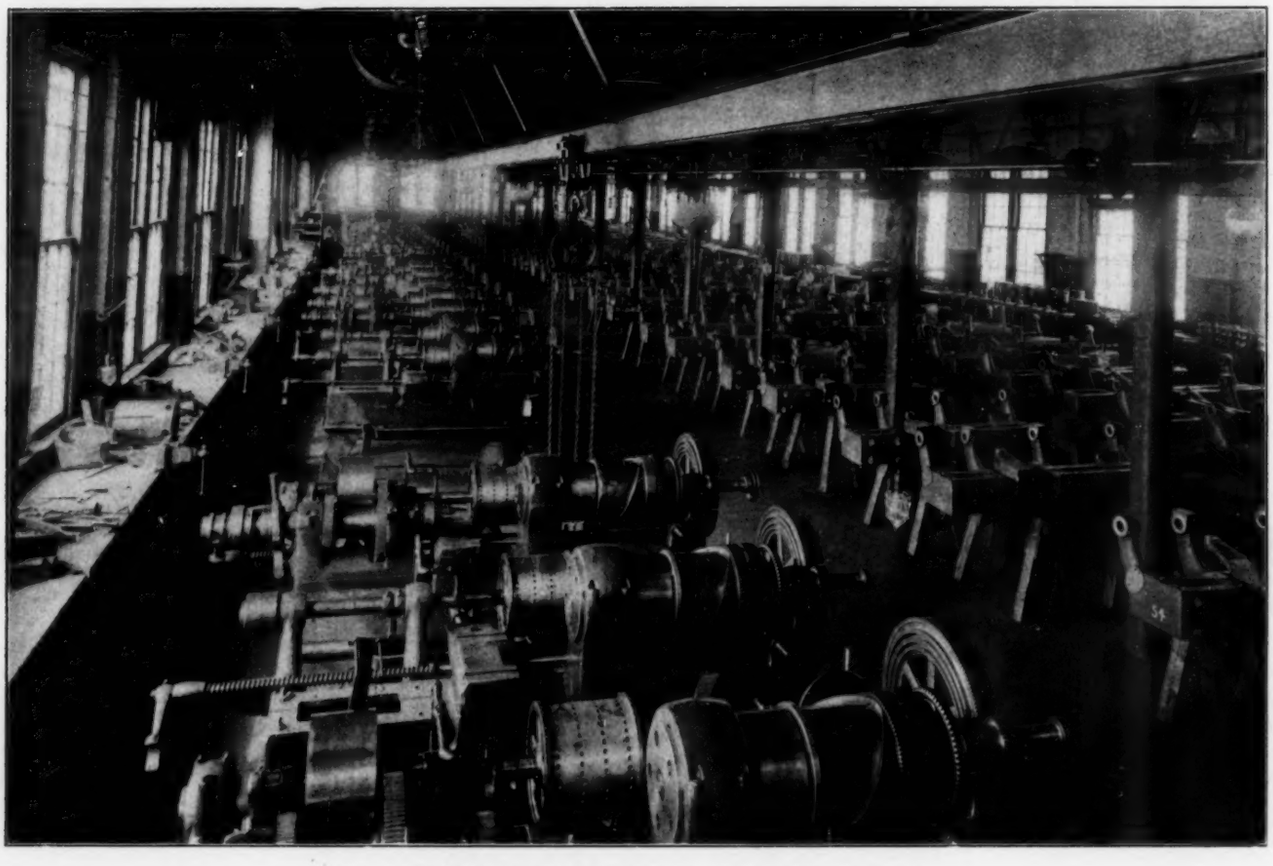


FIG. 9. ASSEMBLING FLOOR CLEVELAND AUTOMATIC COMPANY.

drums, pulleys and other parts not usually finished in this way are here finished by grinding, the result being in every way favorable, the finish being excellent, and the cost not excessive.

Much attention is given to interchangeability in the manufacture of the Cleveland machine, and this means that the tooling is done with the utmost accuracy, in order to do away with as much of the hand fitting as possible, the result being that there is a very noticeable scarcity of vise hands and the number of men working upon the erecting floor is much smaller than is ordinarily found, the effort being, as Mr. Brophy expressed it, to make accurate machining take the place so far as possible of filing, scraping and fitting, in the belief that not only is the work more economically done, but that it is better done.

An interesting result of this interchangeable feature was related by Mr. Brophy, who is president of the company and general superintendent of the works, and who said that a customer of theirs in an accident broke the feed bracket on a Cleveland machine. This feed bracket fully assembled is shown in Fig. 5, and the casting for it is shown in Fig. 6. This casting is bored and placed in the jig shown in Fig. 7, the tools used being shown with it. There are upon it 8 milled surfaces; 26 drilled holes, 5 of which are reamed in the fixture and the rest hand reamed; two holes are drilled and tapped out of the jig and 7 of the holes are counterbored.

When the customer telegraphed that the feed-bracket was broken, a new casting such as is shown in Fig. 6, was sent to him, and in due course a letter was received, stating that not only did the bracket fit the machine properly, but all the attached parts fitted into their places accurately, and when on the machine, performed their functions the same as they had done when working in the bracket which had been broken, and no adjustment whatever was required, nor was there any trouble of any kind caused, except that resulting from the necessity of removing the broken bracket, of taking the parts from it, and placing them in the new casting and this in turn in its place upon the machine.

At Figs. 8 and 9 are shown rather impressive views of an erecting floor in the Cleveland shop, which will give an idea of the very large number of such machines that is put through in single lots.

An inspection of the sample board on the wall of the office in this establishment is most impressive, not only for the very great variety of work shown to have been done by these machines, but also for the intricacy of some of the pieces and their tremendous size, when we consider that only a few years ago nothing larger than one's little finger was expected to be made upon an automatic screw machine. Mr. Brophy says that he now sees no reason why a machine could not be made to handle bars 12 or even 18 inches in diameter, if anyone needed it and was ready to pay for it.

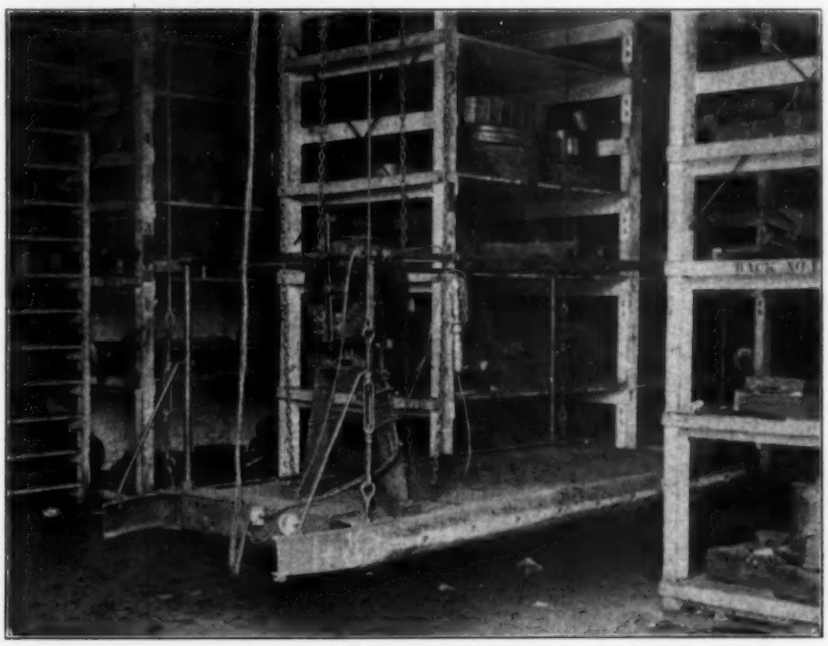


FIG. 12. PORTION OF A PATTERN STORAGE AND HOISTING AND CONVEYING PLATFORM.

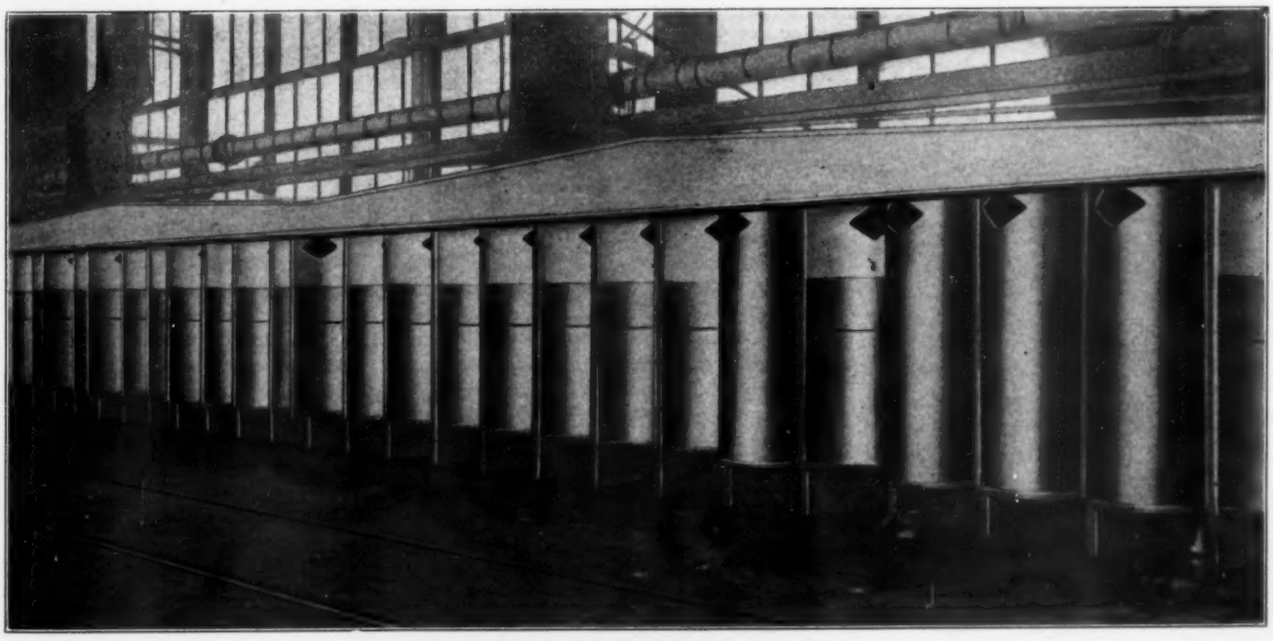


FIG. 11. A SHOP SANITARY APPLIANCE THAT IS NEW.

BROWN HOISTING MACHINERY COMPANY.

One of the most noteworthy shop buildings in America is shown at Fig. 10; besides being notable as a shop building, it is also interestingas a shop constructed of what would be taken for reinforced concrete, but is really a steel skeleton covered with Ferroinclave, an invention of Mr. Brown's. The shop, as will be seen, consists of the large central bay with lateral bays extending at right angles to it, these last being provided with a roof of the now familiar saw-tooth construction, except that instead of the sections of the roof which holds the glass being inclined, as is usual, they are made vertical, which gives greater facility for opening and closing the sash for ventilation, simplifies the problem of removing snow and, Mr. Brown believes, is altogether the best construction.

The interior of the shop is very light, owing to the large window area, and there is no wood construction—all doors, window frames, etc., being of steel.

The engraving is made from an architect's drawing, instead of from a photograph of the plant itself, and though it gives a good idea of the shops, it has, as is the way with architects, been considered necessary to put in a good deal of smoke, because, you know, this is an industrial establishment.

SMOKELESS COMBUSTION.

As a matter of fact, as Mr. Merryweather and myself were starting into the shop, Mr. Brown said to him: "Be sure and show Mr. Miller the top of our smokestack." It was evident that this was said with some pride in the fact that the tops of these stacks were worth looking at. As we approached them, Mr. Merryweather called my attention to the smokelessness of the atmosphere surrounding them, and remarked that it was probable that two of the stacks were at that time in use. After examining them with some care we could not decide from a little distance which ones were in use, but learned when we went into the boiler room which they were. The firing is done by automatic stokers, and things were so nicely adjusted that there was absolutely no smoke to be seen coming from the stacks, although the boilers were being fired at full capacity.

In Cleveland, manufacturers generally take a good deal of pride in avoiding smoke, this being largely the result of the work of Prof. C. H. Benjamen, who was for some years smoke inspector here.

Inside these shops they do heavy work mainly; that is, build machinery which is used for handling coal ores and for conveying various other materials, particularly those used in metallurgical processes.

A NOVEL SANITARY APPLIANCE.

One of the most interesting features in the shop is shown in Fig. 11, and is a shop water-closet of entirely new construction, devised by Mr. Brown, with the object of overcoming the objectionable features of the usual arrangement; an object which seems to be most completely attained.

In front of each compartment and seat there is a piece of sheet steel which is bent into a semi-cylindrical form and this is suspended from the top upon a pivot and runs upon rollers in such a way that it can be rotated about a vertical axis, which, projected, would be coincident with the axis of the cylinder to which the sheet metal is bent. A person entering one of the compartments simply swings the metal shield about him as he stands and then has sufficient room. To emerge he simply rotates the screen again. Some of the compartments are shown closed and some open in the photograph, though a peculiarity of the arrangement is that it is in reality always closed, and nothing of the interior is visible at any time except when one is within the compartment. No one can go into one of these compartments without closing the door, nor can he come out without opening it and when it is open it is also closed. The arrangement requires a minimum of room; it is strictly sanitary; it is neat in appearance; it secures good ventilation; and in short seems to have every commendable and advantageous feature.

PATTERN STORAGE.

At page 639, Part 2, of the volume for last year we showed a plan and elevation of the new pattern-storage building of the Brown Hoisting Machinery Company, which it will be remembered is built with considerably greater altitude than is common with such buildings and has racks 8 feet wide built continuously to a point near the top of the building, with just sufficient room for a crane girder to pass over them. From this crane girder is suspended a platform, which can be hoisted to the hight of any shelf and may be traversed through any aisle between any two pattern racks, and in this way a pattern may be deposited upon, or removed from, any shelf in any portion of the building in the quickest and easiest manner possible. The movement of the crane girder and of the platform from aisle to aisle is by hand, the hoisting by electric motor. We are able to show at Fig. 12 a photograph of this pattern platform, which will give a very good idea of how the thing looks, while the drawings reproduced at the page given above show the layout. The motions of hoisting are controlled from the platform and has proved to be very satisfactory and the arrangement efficient.

At its last convention the National Electrical Contractors' Association appointed a committee to draft a set of signs and symbols with the hope that they may ultimately become adopted as a universal standard in making drawings for electrical work.

Letters to the Editor.

Studies in Inventive Problems Announcement.

It having been my intention to conclude this series of articles in the AMERICAN MACHINIST in this issue, I with much pains prepared the concluding article.

The copy, including the material for producing the necessary engravings was so bulky that to send it by mail safely required a larger and stronger envelope than I chanced to possess.

My time during the office hours of the AMERICAN MACHINIST is so fully occupied with an intricate and difficult design for a recently patented machine as to make it very inconvenient for me to call at the publisher's office and deliver the package. About to send it by express, a highly esteemed and entirely trustworthy young friend kindly undertook the task of its delivery. I accepted the service thankfully. Much to the chagrin of my volunteer messenger, somewhere in the press of passengers on the railway the roll of copy was dropped from among a number of other packages, and notwithstanding advertising a reward and the making of every effort to find it its recovery has not been secured in time for its appearance; and as considerable time has now elapsed since the package was lost, I have abandoned the hope that it will be redeemed.

If, however, contrary to expectation, I should regain the copy, I will forward it to the AMERICAN MACHINIST for publication.

The article as prepared contained all the remaining valid solutions of Problem IX, and all the valid solutions of Problem X, as stated in the following list:

Problem IX: Otto L. Lewis, Indianapolis, Ind.; M. L. Martus, Waterbury, Conn.; Harold Smith, Bradford, Yorkshire, England; J. Oscar Villars, Williamson School, Penn. (two solutions); Leicester Allen, New York, N. Y.

Problem X: J. Melancon, Amite, La.; A. E. Van Campen, Brooklyn Borough, New York, N. Y.; P. S. Bushnell, Lakewood, Ohio; R. R. Deane, Holyoke, Mass.; Henry Diecks, New York, N. Y.; "Anonymous," Milwaukee, Wis.; Frank Meyer, Buffalo, N. Y.; Allan Trevor, Pittsburg, Penn.; Leicester Allen, New York, N. Y.

Some of these solutions were illustrated with a number of figures, and it is as severe a disappointment to me as it will be to the contributors to lose them in the manner described.

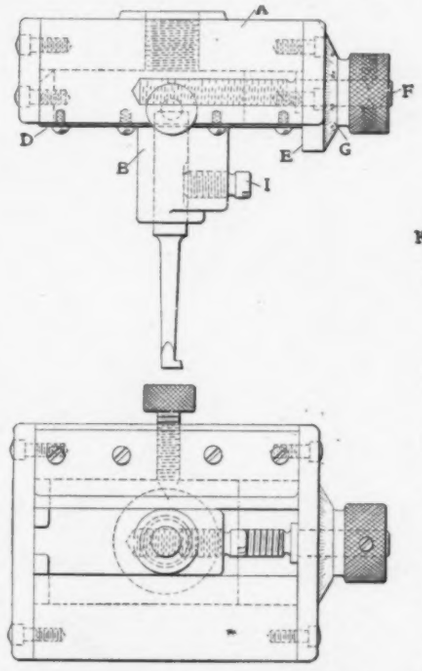
It remains for me to express my deep regret that such a mishap should cloud the success of this series of articles, and my regret that the pressure of other exacting work compels the conclusion of the series. Perhaps in some future time, with the approval of the editor, another similar series may be presented.

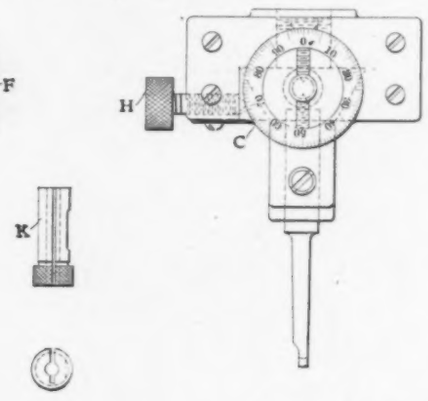
Many of those who have been interested in the solution of these problems,

seem (though I have never seen them) like personal acquaintances. For the present, at least, I must bid farewell to them and all who have joined in the study, cherishing the hope that at some convenient time we may resume our pleasant correspondence. LEICESTER ALLEN.

A Boring-Tool Holder for the Milling Machine.

The boring-tool chuck shown in the illustration will appeal to first-class toolmakers who have experience in locating and boring holes for bushings in drilling jigs and fixtures, on vertical milling machines. It is a tool for saving time and for doing accurate work, and will earn its cost within a short space of time in shops where much jig and fixture work is done. At the present time, in many tool rooms, the boring tools are held in ordinary drill chucks, which necessitates a repeated bending of them for the successive cuts until the required diameter of bore is attained.





A BORING-TOOL HOLDER FOR THE MILLING MACHINE.

The body *A* of the chuck is bored and threaded to fit a milling-machine arbor of the kind used for holding end mills with threaded holes. The slide is made with a projection *B* containing the hole and the set-screw *I* for holding the boring tools. When the slide is brought up against the stop plate *D* the hole is central for carrying locating plugs and drills for starting the bore. Drills smaller than the hole in the projection are held with split bushings as shown at *K*. The slide is moved by a twenty-thread screw *F*, to which a disk *G* is attached, graduated in 100 divisions, to record cuts in 0.001 inch in the diameter of the bore. In the nurled portion of the disk are two headless set-screws with 60-degree points, which engage in two offset holes in the shank of the slide moving screw for taking up the wear between the disk and the thrust plate *E*. The triangular gib *C* is held in place with a thin springy plate fastened to the under side of the body. This plate is made with a slight curve running lengthwise, of sufficient tension to press the gib upward against the slide, cause friction on it to prevent it from moving too freely, and to insure an accurate setting for a cut when the clamping screw *H* is loose. The hole in the gib into which the 60-degree point of the clamping screw enters, is offset downward from the center of the screw, so that when the screw is tightened the gib is forced upward to lock the slide in place. H. E. R. MANBRAND.

Brazing Gray Iron.

I have been interested reading the various articles on brazing gray iron, as I formerly supposed it impossible to braze it with ordinary brass, and this in face of the fact that I had several men in my employ who were devoting all their time to this branch of work. However, the only metals we were called on to braze were steel and malleable iron.

After taking up school work, I found one day that one of the pupils had broken a gear-shifting lever on one of our engine lathes. As I was debating whether to send to the manufacturers of the lathe for a new lever, or send this one to some one who made a business of brazing gray iron, the instructor in the forge department of the school came along and informed me that he could braze it for me. While I was attempting to persuade him that he was mistaken, as this was gray iron, he called my attention to a similar lever on another lathe which he informed me was broken and brazed three or four years previous to my coming to the school.

One of the pupils was instructed to fasten the broken pieces together, the uneven edges occasioned by the breaking of the piece were not touched—that is, they were not smoothed off in any way. The brazing was done in an ordinary blacksmith's forge.

In order to avoid high heats, it was necessary to use a brass that would melt at a low temperature, as otherwise there would be danger of melting the cast iron, whose fusing point is low as compared with that of steel.

In order to get satisfactory results it was necessary to heat the iron slowly, and for a longer period than when brazing steel.

I am sure that the efforts of some mechanics to braze the metal under consideration have proved futile because the brass used had a high fusing point.

Since brazing the lever I have had occasion to braze several pieces, and satisfactory results have attended each attempt.

I trust this may reassure those who are skeptical as to the possibility of doing such work. E. R. MARKHAM.

Doing Worthless Work.

As I was particularly interested in the articles at pages 584 and 585 under the title of "Doing Worthless Work," I feel like adding some experiences and opinions along the same line. What do we mean by worthless work? Let us have a few examples. The man who works for years upon the perpetual motion problem; has he wasted his energies, or done worthless work? I doubt it. His investigation has led him from one fact in mechanics to another until he learns by experience, that certain things will work and others will not. Later on he gets acquainted with a book on mechanics or physics, learns the reason why, and is fitted to produce work *of worth*.

I once worked upon various models of antiquated locomotives and machinery for exhibition at one of our national expositions. The models were of no utility. Was it wasted energy? I think not. I received my compensation, and in addition a useful fund of knowledge. The public was enlightened, investigation for the proper designing of the models brought to light a quantity of forgotten lore, and somebody paid the bill and was satisfied.

There are, however, conditions which will help to define actual worthless work. Some of the conditions are time, commercial value or dollars. A lot of unnecessary work or time expended upon a piece of work which would serve the same purpose if done in a different way in one-half the time and of which the workman was aware, this is no doubt worthless work. True it served the purpose of providing employment and wages to the employee, but how about the commercial end? Will the business last long if many men are employed and all are allowed to do likewise? A man designs and has completed a machine for a certain purpose; it does the work, what more can

he wish? In six months he destroys it and builds another, which does the work better and cheaper. Someone says, "worthless work, he should have seen it when he made the first machine." This statement is hardly worthy of a reply, it indicates thoughtlessness. Why is not every piece of mechanism perfected at its inception? We know it is not and to give the reason would be to relate the history of progress. My experience is that a man with an idea and who has the money to develop it, is not looking for someone to find fault with his device; he is willing to pay someone to boast it up; he will take all the chances and discover the worthlessness of the machine in private where he can in quiet frame such excuses as he sees fit, as to why it did not work. You have to handle him with gloves and let him down easy; the drop is a long one, and he does not appreciate your motives, no matter how well intended, when you attempt to pry too far into details of personal matters, even if to save him expense. This I think answers the question of both Dixie and Mr. S. that a man in business should take every job offered to him if the pay is commensurate with the work required and he can fill the conditions of the contract as to time, quality and quantity of the product required.

Here is an instance of what may be considered worthless work as it had no utility or merit. It was ordered by an official, simply to impress his authority, not even to enforce discipline, which might have been excusable. This happened when I was foreman in a shop owned by several of the high officials of a very large institution. The purchasing agent of the larger institution was also the managing director of the side issue corporation and hence it was his policy to throw all work possible with the latter.

One day I received orders through our superintendent to make four forgings. I explained that the equipment made it impossible to produce them in case-hardened iron, but I could make them of chilled cast iron. The superintendent reported to the manager, who suggested an impracticable way of accomplishing the result and gave it to the superintendent as his ultimatum that they must be so made. I still insisted that I could not and the next day the manager and superintendent went away for a week, and I ordered the purchase of the forgings from a concern doing that class of work. When the officials returned my order was cancelled and I was asked why I did not make an attempt to produce them. I replied, "Because I know it to be impossible as they would cost too much under the circumstances." I was told that expense was none of my business. I replied, "All right, gentlemen, I'll put men on it right away and we'll knock away with the expense a going until you say stop." The manager said, "That is just what I wanted you to do." I tried to again suggest chilled castings and asked why they would not do. He replied. "because I don't want cast iron, that's why." I knew that it was only a whim and that the superintendent and mechanical engineer of the works who were to use the pieces preferred chilled cast iron, for I had privately communicated with them. So we started the job. The next day orders came to consult with the manager for a change, which called for cast centers and wrought case-hardened bands shrunk on. This did not relieve the situation, in fact, complicated it. We worked on this for nearly two weeks with no satisfactory results, when orders came to quit, awaiting further orders. The next scheme was to get the wrought sections elsewhere and we were to complete the job, but the prices quoted for the pieces were so great as to cause the total abandonment of the whole case-hardened proposition and to my surprise I received instructions to make them of chilled cast iron, which was done successfully, and when billed the whole cost was attached. Now, was this not a good case of worthless work? The parties who were to use the work and the parties who were making it were agreed as to what was practicable both for use and production. But the officialdom, who had no knowledge of either, took a notion that something else would be better; they controlled the money bag and influence, hence the worthless work.

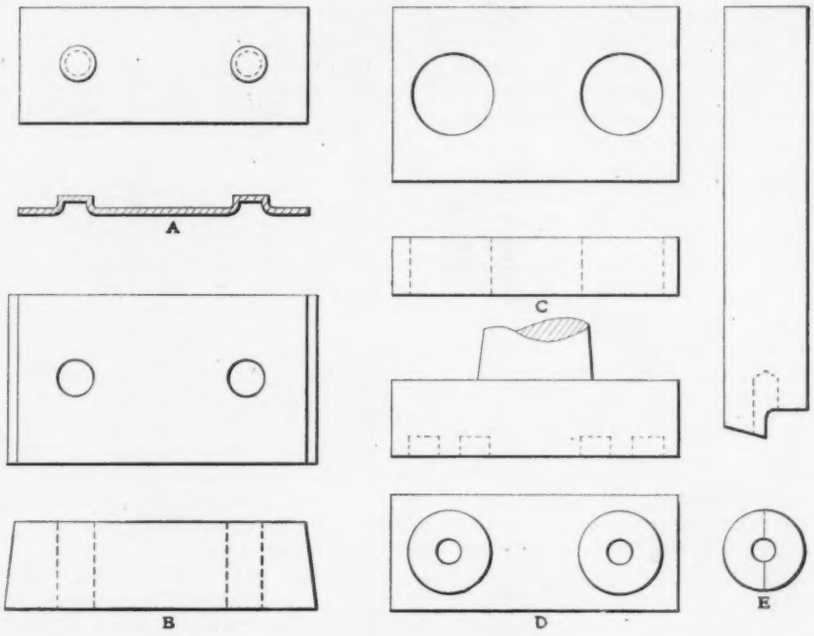
Worthless work always has been done and always will be. All is not worthless work that so seems and some work that is thought to be of value often proves worthless, but if we can convince ourselves that the other fellow has some rights, and try to look upon the bright side we will find that there is not as much worthless work as we supposed?

C. B. CARTER.

Forming Rivets in Soft Sheet Steel Parts.

It is easy to assemble work that has rivets struck up in soft steel stock far enough to allow the riveting of small parts of thin gage, such as flat springs, etc. This method of handling work is used extensively in manufacturing sewing machine attachments and will be found accurate and a labor saver.

The work is shown at *A*. The die *B* and punch *D* are made in the following manner. Drill and ream the die to the outside size of the rivets. Transfer the holes in the die to the templet *C*, made of steel, and counterbore the holes in it for the hollow mill *E*. Clamp the templet *C* on the punch *D*, to guide the hollow mill *E* for forming the tits on the punch, remove the stock from around the tits that are formed and the tools are ready to harden.



THE WORK AND THE TOOLS.

The same die will answer to punch the holes but it is better to have two dies, gages being screwed on the die to locate the work.

G. K. STEVENSON.

Bending a Pipe With a Spring for a Core.

A light soft copper pipe 1⅛-inch inside diameter required bending in a hurry with no coppersmith available, and a kink, new to me, was put in operation to do the job.

A close-coil spiral spring 1⅛ inch outside diameter was pushed up inside the pipe with a rope attached to the end of the spring. The usual procedure with pins and bar did the job in a satisfactory man-

ner, the spring accommodating itself to the bend while preserving the cylindrical form of the pipe. The rope of course pulled the spring out none the worse for its unusual task. A. L. HAAS.

London, Eng.

Small Spindle Work.

Many small circular castings are readily molded without complete patterns by means of the center plate and spindle. In Fig. 1 are views of a plate 2 feet 6 inches diameter and a 1-inch spindle. The spindle is cast in the plate, the tapered point being smeared with oil and plumbago, and as soon as the metal is set the spindle is turned and lifted from out of the casting. Three legs and four handles are cast attached to the plate as shown. The arm *A*, Fig. 1, is of cast iron. The whole rig is inexpensive and

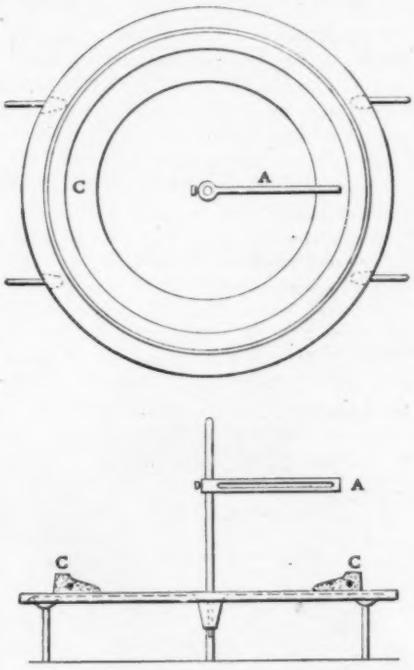


FIG. 1. PLATE AND SPINDLE FOR SWEEPING SMALL WORK.

is extremely useful for the making of cores and molds, both in green sand and loam, according as the nature of the work requires.

Fig. 2 is a sheave pulley 2 feet 3 inches diameter which was recently made with the aid of the above plate and spindle. Fig. 3 are the sweeps required for this piece; *B* is used for sweeping up halves of the groove, one of which is shown on the plate in Fig. 1 at *C*. These parts are swept up in loam and dried and then joined as at *D*, Fig. 4. The second sweep *E* is used to form the mold. The dotted line on the sweep is the shape of the sweep used to form the cope when striking up the mold, the cope being rammed on the bed formed as at *F*, Fig. 4. The cope is lifted off and the sweep used as on the sketch *E*, Fig. 3. The loose piece is located by two dowels and secured by screws. The drag part is swept out by means of this sweep and is shown at *H*, Fig. 4. GEO. BUCHANAN.

A Boy's Objections to Serving an Apprenticeship.

I have taken great interest in the various articles appearing in the columns of the AMERICAN MACHINIST relating to the

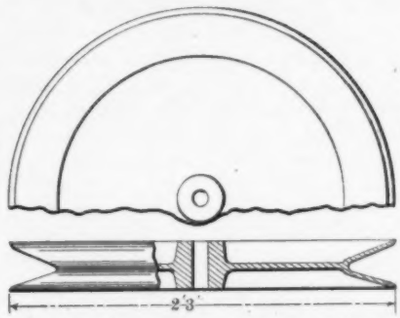


FIG. 2. SHEAVE PULLEY CASTING MADE BY SWEEPING.

apprentice problem, and each succeeding letter has brought out some new phase of the subject. I was forcibly struck by a remark in one of the articles, to the effect that it is difficult to secure bright, intelligent young men as apprentices. Within

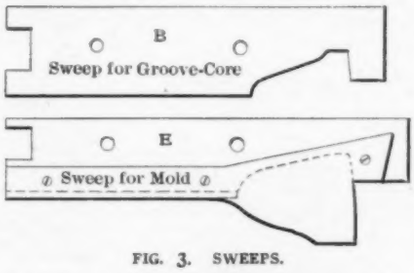


FIG. 3. SWEEPS.

my limited observation this has undoubtedly been true, although until I read the remark mentioned it had never occurred to me that such was the case. As every existing condition has a legitimate cause, I naturally asked myself the question, wherein lies the fault? I finally concluded that the best source of information on the subject would be the bright young chap who has considered entering on an apprenticeship, but for some reason, which I wanted to discover, has given it up as a wrong course to pursue. Fortunately I had an exceptional opportunity to question one in this position, and I am sure that the result of my interview will be interesting to those who have been discussing the subject. I know that I was surprised that anyone could have so dark a view of the shop; yet, although some of his opinions were radical, I cannot entirely blame him for them.

The young man in question is very intelligent, with strong ambitions and undoubted mechanical ability, his family for two generations having made a marked success in the mechanical field. His friends advised him to take an apprenticeship in a shop manufacturing high-grade machine tools, where he would have the best of experience. His father was especially insistent in trying to induce him to follow this course, but without avail. Instead he has chosen dentistry as a profession, because the environment is more congenial to him and the work is the nearest approach to the mechanical that can be found in the professions, thus giving him the advantage of his natural talent. The gist of his reasons for declining a purely technical training in the machine shop follow, and, needless to say, some of them are well grounded, for he has had the opportunity for observing actual shop conditions.

1st. The management of any up-to-date factory gives the cost and quality of the product first consideration, to the extent that it becomes a detriment to the education of the apprentice. They will (sometimes unconsciously) impose upon his good nature and take advantage of his dependence if they consider it profitable to the company to do so. Nor can the management be justly blamed, because they are in business for profit and not for education; yet that does not change the effect on the apprentice. Often, after he has mastered one branch of the trade, his foreman will keep him on the same class of work for a time, because it pays to do so, for he thus gets good results from a low-priced man.

2d. The opportunity for an all-around experience such as our fathers had the advantage of cannot be found today. The forge, the foundry and the pattern shop are all cut out of our apprenticeships, and the three and one-half years of work is confined strictly to the machine shop. The regular work to be done is machined with special fixtures and requires no great accuracy or care on the part of the work-

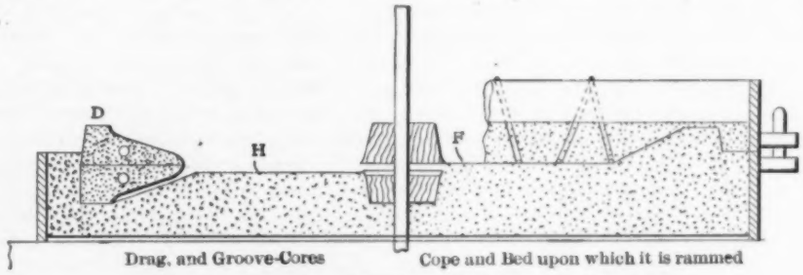


FIG. 4. SECTIONS SHOWING PROCESS OF MOLDING.

man. The only place in which the better grade of work is done is the tool room, where these fixtures are made, but on account of the number of apprentices employed only a small per cent. can take advantage of this experience, and one's chances for it are slim. Running small parts through the shop in large lots is another condition which the apprentice years ago did not encounter. The monotony of a lot of several hundred pieces to be polished or drilled by a jig is an unpleasant reality.

3d. The associations are bad; seemingly worse than in any other branch of learning which requires good judgment and skill. Vulgarity and profanity are apparently taken as a matter of course and the effect is apparent in time on even the best who enter the shops. Many of the foremen are not over careful in this respect and their influence by example is very marked on the boys in their charge. This influence was blamed for the fact that the social standing of the machinist is not so good as in other lines. Soiled clothes, necessarily so, will not affect social standing with desirable society, but if one's surroundeings are the very opposite of cultivated and refined it is evident that their effect will be felt socially and justly so.

4th. The environment is not conducive to good health. Dust is always present and constantly inhaled and very often the ventilation is bad. It is not unusual to see a boy pale and listless who, when he first entered the shops, was robust and full of life. Numerous instances were cited which seemed to prove that this assertion is true. Whether the result of unsanitary conditions, unpleasant environment or the evil effects of bad associations the fact of declining health was certainly evident in the cases mentioned.

5th. So many cases have been noted of apparent injustice from foremen that the prospect of a like experience is discouraging.

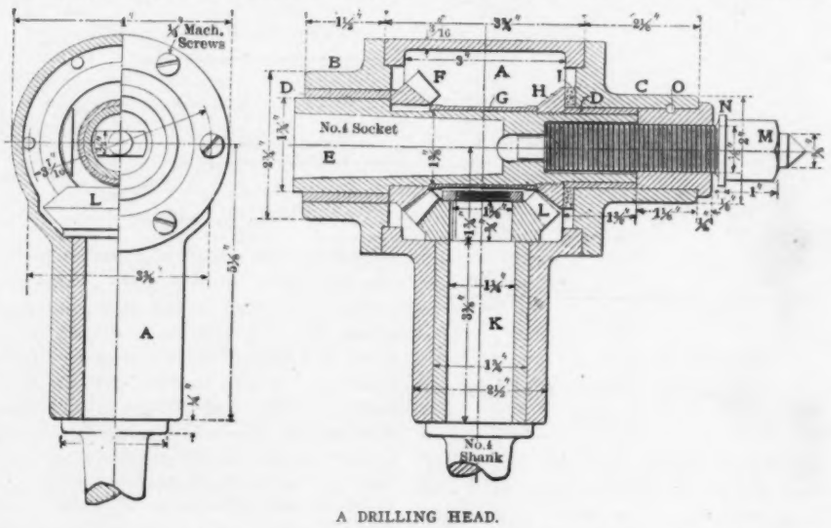
6th and last. The machinists' union really makes the workman its slave instead of giving the protection it claims. The workman is not a free agent but, even though contrary to his conviction of right, he must obey any ruling which they see fit to make. No man desiring independence could feel satisfied in a position like that.

The foregoing comprises the principal objections mentioned and it would seem that they came from one who was morbid and pessimistic. However, the contrary is true, for the young man in question is of a cheerful disposition and tries, I believe, to be unprejudiced and open minded, willing to study both sides of the question, and his conclusions are the result of deliberate thought on all phases of the subject. No doubt there are many who will say that some of the conditions mentioned do not exist and his fears are without cause, and it may be that some shops have a very few of them. Yet I believe that, on the whole, and to a greater or less extent they are very general, and surely the prospect is not a cheerful one for the young man who is about to choose his life work. A separate shop with more ideal conditions for apprentices only, as has been suggested, may be a step toward a solution of the problem, but I fear very few companies will see a profitable investment in the erection of such a building. The trade school having the same requirements would do just as well if the work was conducted by a practical business man on a manufacturing basis, yet the prospect of working in other shops with inferior conditions after the trade is finished is not a pleasant one. Before it is possible to induce the best and most desirable material to enter the trade it is necessary to improve existing shop conditions. Certain it is that many good young fellows with marked mechanical inclination will never enter the machine shop because the environment is distasteful to them.

PESSIMIST.

A Drilling Head.

The accompanying sketch illustrates a drilling head which is very handy to have in the shop. This tool has been of great use also out of the shop where, with a smaller air drill as the motive power, it



A DRILLING HEAD.

was found more satisfactory to use than the usual hand ratchet.

The body *A* is a steel casting, as are the heads *B* and *C* which are secured to the body with ¼-inch machine screws. Each of the heads is bored and bushed with hard bronze bushings *D* to serve as bearings for the socket spindle *E*. On this spindle is keyed the driven miter gear *F* of 16 teeth, 6 pitch and 5/8-inch face. Collar *G* is slipped over the spindle and the steel thrust collar *H* is screwed up on a left-hand thread, bushing *G* serving to keep gear *F* in its place and maintaining a positive distance between the hub end of this gear and the face of the collar or nut *H*. This nut takes all the thrust when the tool is in operation and has its bearing on the hard fiber washer *J* which is ¼ inch thick. The driving shaft *K* is bronze bushed, with driving gear *L* keyed to the end and held on by a steel nut. Both gears are made of soft steel. The feed screw *M* is formed with a hexagonal head 1⅛ inches across flats and has 3¼ inches of thread with a tip 7/16 inch diameter for screwing down to push out the drill. The screw is threaded into the steel bushing *N* and the latter is screwed into head *C* and locked in position by a 3/16-inch taper pin *O*.

BAYARD.

California.

Apprentices in a Small Shop.

I should like to know if everybody that is running a machine shop has the same experience with boys.

In large shops a boy is likely to be kept at one thing most of the time and the only chance he has is to learn how to run one machine. In small jobbing and manufacturing shops, however, a boy has a chance to become an all-around machinist and learn to help himself, as a small shop cannot afford to buy tools for every new job, but must fit up and make the standing equipment do.

When you get a boy he wants all kinds of money, anywhere from five to seven dollars weekly while we had to start with three or four dollars; and then he will not stay in one place but will go in any other business where he can get more money. I had a boy who started in and after a month left to go with a plasterer, and after trying that decided to go with a mason, all in less than two months, as there was more money in it.

What I want to know is, where are the future all-around machinists coming from? I think many others are interested in this question. The whole trouble is that the present crop of boys cannot see the value of learning a trade. Another trouble lies in the fact that many boys learn (?) a trade in six months or a year at most,

while it took others four or five years, and then they had much to learn.

Since writing the above I have read the article at page 455, and cannot say but what "Apprentice" is right in regard to large shops, but how about small ones? I have a boy one day on the grinder, another day on the drill press, and then punching. If I have a job that lasts for weeks, I change the boys around. This may not seem economical, but it is; for if one boy leaves, one or two of the other boys are familiar with the work that he was doing, and a new one can gradually be broken in. HERMAN JONSON.

The Smallest Steam Engine on Earth.

To those who are familiar with the size and power of the largest steam engines that are built today it is a rather big drop to a consideration of a perfect-working

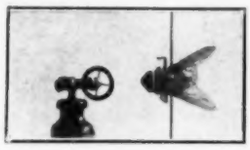


FIG. 1. THE ENGINE FULL SIZE.

engine smaller than a common house fly, and weighing complete just 4 grains troy, about the weight of a small pine match.

Yet such an engine has just been made by Thos. H. Robinson, a watchmaker of Toronto, Ontario. It is beautifully finished and made of gold and steel. Compressed air is used to run it, and it attains a speed of 6000 revolutions per minute. When running 100 revolutions per second it emits a note similar to that of a mosquito, no motion being visible to the eye. The feed

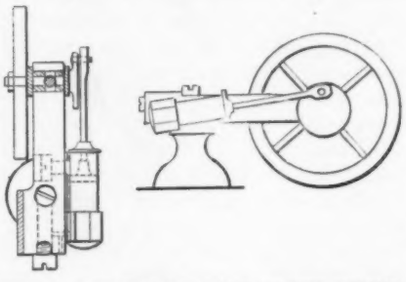


FIG. 2. THE CONSTRUCTION OF THE ENGINE.

is through the stand, which is hollow. The engine bed, stand and rim of fly-wheel are of gold; cylinder, piston rod, crank and center of fly-wheel are steel. Bore of cylinder 3/100 of an inch, stroke 1/32 of an inch and horse-power 1/498000.

The horse-power and speed were carefully estimated by Prof. C. A. Chant, of the physical department of Toronto University. It was shown before the Canadian Institute by request, where it was exhibited running, examined by magnifying glasses, and its construction shown by lantern slides.

Experts called it a wonder and were of opinion nothing smaller or lighter in the engine line was ever made.

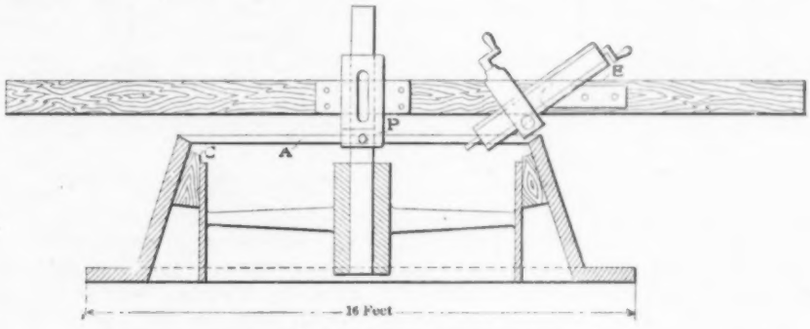
It would take 120 similar engines to weigh 1 ounce, 1920 engines to the pound and 3,840,000 to the ton. The shaft bearings are made of hardened steel, ground and fitted to the gold bed; being recessed on the inside, the friction is lessened as well as forming an oil recess.

At present it is shown in his shop window at 526 Yonge street, alongside of a .22 caliber short rimfire cartridge shell, into which it easily fits, fly-wheel and stand included. It forms a great attraction for those who are able to appreciate so fine a sample of mechanical ability.

Fig. 1 shows the engine full size. Fig. 2 is a rough pen sketch, not to scale, but shows construction. T. H. R.

Facing the Edge of a Large Casting by Hand.

The illustration shows how we faced a large furnace hopper for a blast furnace. As our largest boring mill would only swing ten feet we had to rig up for the job. We found a large pulley which we keyed into the inside with wooden keys *C*. A piece of shafting was then obtained and secured in the bore of the pulley. A collar *P* was put on this and an old bearing to which was attached the beam. We then secured an old slide rest to the beam at *E*. With two men to turn the



FACING A BLAST-FURNACE HOPPER.

beam and feed the tool in by hand, the job was done in about a half a day. The hopper was in six sections bolted together, and as the surface of *A* was very rough we had to take several cuts.

C. R. MCGAHEY.

Planing a Piece too Big for the Planer.

I was recently called on to plane a bed which had been designed to just pass between the housings on my planer, but had swelled so that it lacked about ¼ inch of doing so. Foreman said "Chip it," but I thought of a better way, which has probably been used by others but may be new to many. I have an extension tool holder which advances the tool about 12 inches, bringing it 24 inches from the housings. I set the casting so one side would clear the housing, then chipped a vertical groove down the opposite side 23 inches from the end next the housings and with the extension tool planed off the necessary amount as far as this groove, then repeated the operation chipping another groove 23 inches from the first. F. F. F.

Minimizing Shrinkage Stresses in Balance Wheels — Is Regular Foundry Practice with Fly-wheels Wrong?

I have read the article "Minimizing Shrinkage Stresses in Balance Wheels" at page 742 with a great deal of interest, and much of it has been caused by what is, to me at least, the very peculiar behavior of the author's flywheels, or balance wheels as he calls them.

Judging from the views presented the wheel that has given Mr. Maddock trouble does not differ materially from the usual run of flywheels, except that it seems to be somewhat larger in the bore and hub than is usually the case. While the wheel is not much out of the ordinary it behaves very differently from anything I have seen. I have never seen flywheel arms draw away and crack in the cooling but I have seen the rims crack. All our efforts are put forth to equalize the time of set of the iron, and our reasoning is something after this order: In a large wheel with rim and hub of heavy section the arms will set first in spite of all efforts to prevent it. If the hub is of ordinary dimensions, and the sand has been dug out of the bore as soon as it is safe to do so, the hub will not be very much behind the arms in setting and in cooling. The rim, being of much larger section, will be much slower in setting and also in cooling. Owing to this action it will be found that there is a tendency for this part of the wheel to draw and if a wheel is broken up and examined carefully in the rim where the arms join it will be found that the iron is more open there than at any other place. Very often there will be an open spongy spot of considerable dimensions there, and the reason that it is at that particular spot is simply that it is the point of greatest section, and the point

where the fluid iron solidified last, and there wasn't iron enough to solidly fill the space enclosed by the hard outer shell, and the shell was stronger than the iron inside.

If the time of set can be equalized there will be no tendency for the hub to pull the arms apart, nor for the arms to desert the rim and cleave to the hub, nor for the rim to try to crush the arms and burst in the effort.

This ideal condition, it is altogether likely, is seldom perfectly realized in every-day practice, but that it can be reached within safe limits and without going to the expense as set forth by Mr. Maddock is certain. To get as near a balance as possible every means should be taken to have the hub set first. To do this it must be cooled, and to cool it the core must be taken out at the earliest possible moment. In our own work it is not an unusual thing to have the casting "bleed" a little in the bore because the sand has been taken out a little bit too soon. If the molder uses a little water to help blow out the core it will help the cooling along. Just how far it is best to go in cooling the rim must be carefully considered. The shape and size of the section have much to do with it.

If the arms are of heavy section compared to the section of the rim keep the rim as well as the arms covered, and when the casting is cold there will be a compression stress on the arms. I think a little consideration will make this clear. Everybody recognizes that iron expands when heated and contracts when cooled, but it is not always easy to follow the effects of these actions. For instance if the hub alone of a small, chunky, solid, flywheel is heated it will decrease the diameter of the hole, because the iron is expanded into the hole, being resisted by the arms and rim. In the case of the flywheel casting, if the hub sets first and is encouraged properly it is cold long before the rim is; the arms are getting some heat from the rim and while they are shortening in length the rim is decreasing in diameter, and the rim being the last thing to cool puts a crushing force on the arms and hub while it has a rending stress within itself due to the resistance of the arms and hub.

I should attribute the beneficial action of the treatment given by Mr. Maddock to the annealing action of the long sustained heat, and it certainly will do no harm, but it should not be necessary.

It is not very clear just what the proportions of his wheels are, but if the views shown are about to scale they are not unusual except as to hub. I make them out as follows: Taking the outside diameter of the rim as 60 inches its section would be 7 inches square, the diameter of the hub full 17 inches, and the bore over 8 inches, while the arms would be 2⅞x4⅞ inches at the rim and 3⅛x5¾ inches at the hub. The hub is 7 inches through.

If these sizes are approximately right it certainly would not be wise to cool off both hub and rim so as to have them set solid first. My idea would be to uncover the center of the hub and dig out the core and allow the rest of the wheel to remain covered, and if necessary to keep in the heat have it covered more, and let it stay there until morning, or even longer.

His condemnation of the practice of the foundrymen in stripping the sand from the rim and hub of a wheel should not pass unchallenged. There is a right and a wrong way of doing almost everything, and it has been the way always of the man who did a thing in the wrong way to condemn the thing instead of condemning his methods of doing the thing. Thousands, yes, and hundreds of thousands of solid flywheels have been made and done service under the severest kind of usage without failure, after just the treatment which he says is exceedingly dangerous. I would like to call attention to a very common practice that is exceedingly dangerous. I wish I could make it so emphatic that it could never be forgotten.

It is exceedingly dangerous to copy another man's methods unless all of your conditions are exactly the same as his, and it is certainly unfair to condemn his practice because of your own failure.

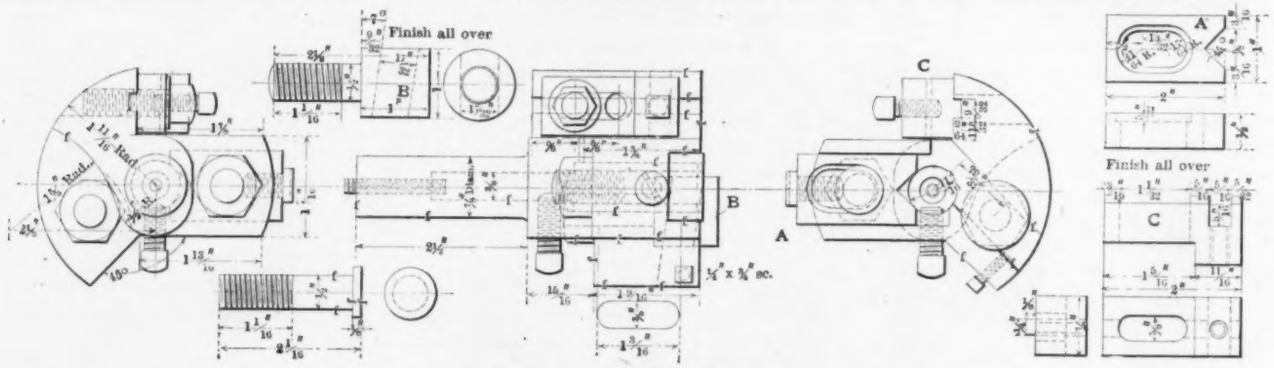
It is not very safe, either, to conclude that because a thing comes right for a time the strains are equalized. It is a common thing to have the arms of pulleys crack, and besides looking carefully to the way they are cooled it is necessary to use for them iron that has little shrink and that is strong and soft. When I say strong in this connection I do not mean stiff, but limber. The kind that will bend and stretch a lot before it will break. If the arms of a pulley are sound when the pulley is finished in the shop they will seldom fail in service, and the reason is plain. The turning of the rim takes off quite a percentage of the metal and reduces the stresses in the arms, and in practice the pull of the belt helps to counteract the effects of centrifugal force.

Remembering the simple fact that under equal conditions the thickest section of iron cools the slowest, it is easy to see that the arms of pulleys of ordinary design are in tension, while the arms of flywheels are in compression, and the degree of either depends on the sections and on the treatment they receive in casting and in cooling.

W. OSBORNE.

A Box Tool for the Automatic.

The blue-print shows a special box tool, to be used on any single-spindle



BOX TOOL FOR THE AUTOMATIC.

automatic screw machine for the purpose of making cup and cone point set-screws.

In our department, we have quite a variety of screw machines, and this tool was designed along with a few other schemes to bring the output up to a good daily average. It consists of a steel forging with a hardened cast-steel rest *A*, which is easily adjusted and locked for any diameter from ⅛ to ⅜ inch. The turning tool consists of a piece of Novo steel inserted in part *B* which is easily adjusted to any diameter by loosening the nut, and setting up the screw. Block *C* holds in position the bevel pointing tool which can be set to any required length, and the shank or stem of the box tool has a high-speed drill inserted with an adjusting screw to back it up. We have made on a ten-hour run on a Cleveland automatic twenty-two hundred ¼x¾-inch cup point set-screws. The machine now runs at the rate of one screw in fifteen seconds. The cams on the machine are run at full speed until the point of the screw is reached and then the speed is reduced so as to finish a fine point and neck. There is also a spare tool, which

is kept ready so that no time need be lost while sharpening tools.

Davisville, Ont. W. LOACH.

Bending Dies.

In Fig. 1 is shown a blank *a*, cut and pierced by the usual tools, not shown here; *b* is the result of the first bending operation and *c* the finished article. The pieces were made from cold-rolled stock 0.062 thick. Before they were made in the tools shown some tools were used which necessitated three separate handlings. They were formed as at *b*, then closed and afterward planished.

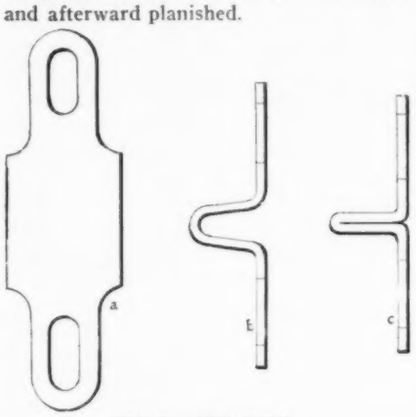


FIG. 1. THE WORK.

Fig. 2 shows a plan of the dies themselves—for there are really two dies placed side by side in one bolster. *A* is the front die and *B B* the moving parts of the rear gear. *C C* are mild steel pins which are a push fit in bolster *D* and in the dies.

Fig. 3 is a section on line *x-y*, Fig. 2, and shows plainly the construction of the rear die which consists of a piece *E* arranged to receive the sliding members *B*. It will be seen that when pressure is put upon the latter they will descend and approach each other. Pressure pins are placed beneath them as shown, and also a spring to expand them on the up stroke. The angle of the slides is about 15 degrees.

Fig. 4 gives a side view of the front die *A*. It is formed with a locating pocket for the blanks on the face, and a hole is provided for a spring plunger. The front and side views of the punch need no explanation.

The dies *A* and *E* are a driving fit in the bolster which is gray iron. The sliding pieces *B* are at the same hight as the die *A* when the press is at rest.

In operation the blanks are placed in the die *A*, raised, and then placed on *B B*; no locating is here necessary. After the first one a finished article is produced at each blow, as there are two blanks in the dies at the same time. CYCLO.

B——, England.

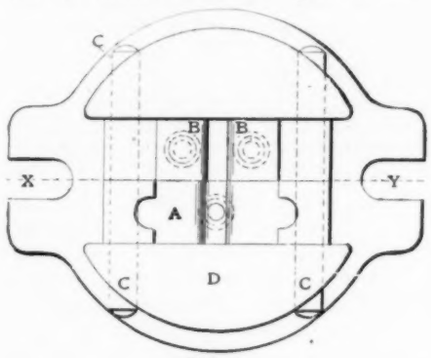


FIG. 2

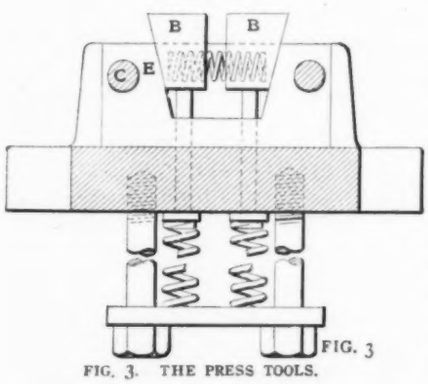


FIG. 3

FIG. 3. THE PRESS TOOLS.

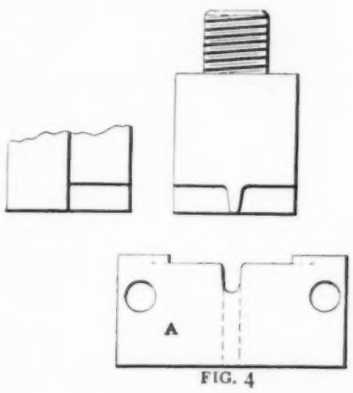


FIG. 4

Use and Abuse of Tools.

It is so natural for us to criticize hastily and not look for any reason that the other man may have had for doing as he did that it sometimes appears as though we were looking for trouble rather than to avoid it. Therefore I was very glad to see Mr. Osborne, in writing on the use and abuse of tools at page 647, take up the other side of the question in his able and entertaining way.

I like kindly criticism, however, even though it be severe, and believe that much good comes from it and that many of our best appliances have been brought to their perfected state largely through criticism.

There are workmen who will not do any kind of work without the tools that they think are best adapted to each particular job. While such men do good work they should at the same time learn to adapt themselves to circumstances or they will never be as valuable as they might be, particularly at jobbing work.

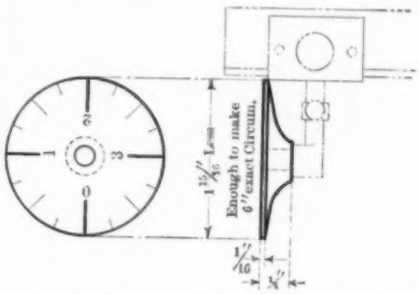
There is nothing that will show a man how few tools he can get along with so well as some of the experiences Mr. Osborne has related in some of his "Echoes" about going out a long way from the shop and having to carry his tools along, not knowing what he would be obliged to do until he arrived at his destination.

Such experiences are not often pleasant but are always valuable.

M. H. BALL.

Measuring the Length of Curved Arcs.

The accompanying sketch shows an attachment for beam compasses for measuring the length of curved lines. The circumference of the wheel is 6 inches, and is divided into 16 parts, each part being equal to ⅜ inch, and the space between 1 and 2 being equal to ¼ of 6 inches or 1½ inches.



ARC MEASURING WHEEL FOR ATTACHING TO BEAM COMPASSES.

A. MCALPINE.

Clamps for the Milling Vise.

Some of the men employed in our shop seemed to be blood relations of Chordal's "wrench fiend," as they persistently broke the cast-iron vise clamp at *A*, Fig. 1. New clamps were obtained from the makers, only to meet the same fate after a short period of service, so to provide against further damage, a pair of clamps was made as shown on a larger scale in Fig. 2. A bar of 1½x⅝-inch unannealed tool steel was cut off long enough for two clamps, and after machining the bottom face flat, a series of holes was drilled to cut the piece in two, a large hole at the middle of the width, and smaller holes near the edges. This left comparatively little stock to remove with a file when shaping the concave ends to approximately fit the vise body. The back ends were provided with feet, as shown at *B*, Fig. 2. These were made of ½-inch round machinery steel, the reduced portion being a force fit in the body of the clamp. These clamps have been in use some time now,

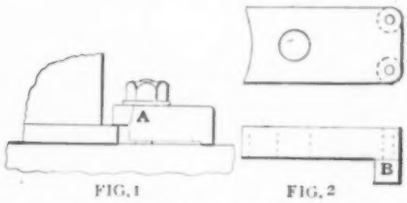


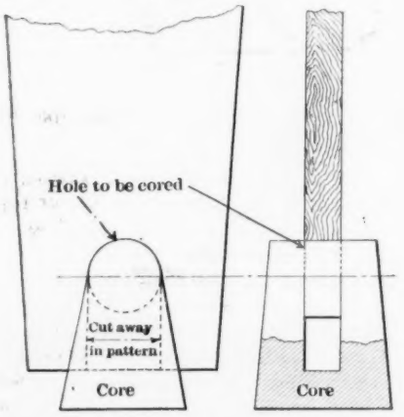
FIG. 1 FIG. 2

CLAMPS FOR THE MILLING VISE.

but none of the herculean gentlemen who operate the milling machine have, as yet, succeeded in doing any damage to them. It was suggested that the cast-iron clamps broke not because of any inherent weakness, but because of improper placing, as shown in Fig. 1, where the clamp is not pushed clear up to the vise body, but rests only on the extreme outer edge of the flange. A. M. A.

Using the Core instead of a Core Print.

Herewith I send you a sketch showing a method of coring holes without employing the usual core print. It often happens that holes are required at the end of some arm where an extra long print would have to be used, or it may be, brackets or some other part of the design may interfere. In such cases, the plan given here will fill the bill. It will be necessary to cut a slot out of the pattern from the



USING THE CORE INSTEAD OF A CORE-PRINT.

holes required, to the edge, as shown by by the dotted lines seen in the left-hand view. The core is first made and dried, then placed in position and rammed in the mold. The pattern is withdrawn and the core remains in place. The dovetail form given to it prevents its moving when the metal is poured. I believe that many of your readers who are interested in pattern making will be pleased to see this, as I believe it is not generally known. I never saw it before using it myself.

Oneonta, N. Y. WM. NEWTON.

Perry's Gas Engines.

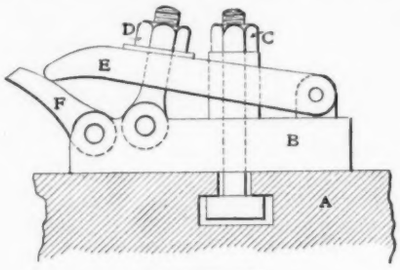
The first two American gas-engine patents were granted to Stuart Perry, one, No. 3597, May 25, 1844, and the other, No. 4800, Oct. 7, 1846. The first of Perry's motors was 2-cycle, air cooled, and the second patent, also 2-cycle, for a gas engine water-cooled, hot-tube ignition. At the time of the first patent Perry lived in Newport, New York, and his residence was New York City when his second patent was granted.

Perry appears to have built some gas engines in New York City, 1844 to 1848. The writer wishes to obtain all possible information as to these Perry gas engines, and will be greatly obliged to anyone who can give any assistance.

HORACE L. ARNOLD,
738 East 32nd street, Brooklyn, N. Y.

A Planer Dog.

The sketch shows a planer dog which I saw recently in a German shop. *A* is the planer table. *B* is the base of the dog which is secured to *A* by the bolt *C*. *F* is the toe that bears against the work, the



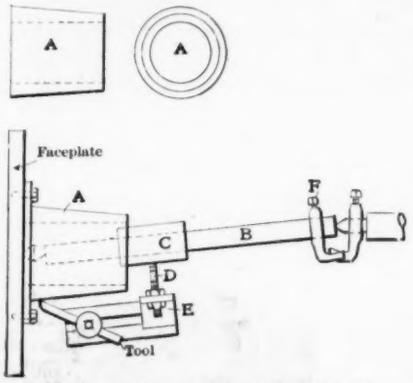
A PLANER DOG.

lever *E* forced down by the swinging bolt *D* forces *F* against the work.

Germany. O.

An Improvised Taper Attachment.

A is a gray-iron ring to be bored, faced and turned, the outside to taper 3/8 inch per foot, and not a lathe in the shop with a taper attachment. I was told by the boss to bore them, cut them off—the castings had lugs for bolting to the faceplate—and make an arbor to turn the outside. This set me to thinking. I got a piece of 1 15/16-inch cold-rolled steel *B*



AN IMPROVISED TAPER ATTACHMENT.

24 inches long, centered it to run true, making the centers rather large. An old pulley hub *C* from the scrap-heap bored to slide free on the piece of steel was drilled and tapped for a 7/8-inch stud *D* 8 inches long. The other end was threaded for 4 inches. A small angle-plate *E* to bolt on the cross slide with a 7/8-inch hole for the end of the stud to slip through, with a nut on each side of angle-plate. A dog *F* was put on the end of the steel bar and another one on the tail center to hold the bar from turning. The tail center was set over 3/8 inch and the cross-feed screw removed. The plan of the outfit is shown. On an 18-inch lathe it did a grand job, and in half the time it would have taken with an arbor.

TOM TANYARD.

A Shellac Chuck.

For certain kinds of fine work, such as holding pinions for polishing, the so-called "shellac chuck" will do good service if it is made right and handled properly. It consists of a chuck with a thread to fit the lathe at one end, and at the other a cone in which the article to be worked is fastened by means of shellac or its equivalent. The shellac is warmed, and then while one end of the work is put on the dead center, the other is pressed through the shellac to the bottom of the cone cup, thus insuring perfect centrality. The warm shellac is next built up around the end of the piece while the work is centered, and the latter is then ready for working, as soon as the shellac is cold. Unfortunately the gum often gets cold too soon, so that the object cannot be pressed clear down into the cone, or at any rate the shellac cannot be built up in the cup sufficiently to hold the piece.

SHELLAC CHUCK.

This is because the metal of the chuck conducts the heat away too rapidly from the shellac.

The way to make the chuck do its duty every time is to bore two good-sized holes clear through its body at right angles to each other and to the axis, thus reducing its cross section without materially lessening its torsional strength. Another way is to bore out the body of the chuck from the threaded end very nearly to the bottom of the cup. This has the same effect as boring the two cross holes, and besides being more sightly, does away with the danger of anything catching in the holes. ROBERT GRIMSHAW.

Hanover, Germany.

The largest electric sign in the world has recently been erected at the coal storage plant at Shadyside, N. J., and can be seen from Riverside Drive, New York City, across the Hudson for a long distance. It reads, in three lines: "COAL STORAGE 200,000 TONS," "THE NEW YORK EDISON CO.," "55 DUANE ST," the letters in the middle line being 14 ft. high and the others 5 ft. The sign is 160 ft. long and 91 ft. from the ground to the top, has 1800 8-c.p. incandescent lamps and there are 70,000 lb. of steel in its light framework. This is not only "practicing what you preach," but is setting a brilliant example.

Bench and Countershaft Arrangement for Bench Lathe.

This bench as shown in Fig. 1 is so constructed as to admit of being placed in the center of the shop or experimental room, or at any other convenient point where light is available. It measures 6 feet by 28 inches and a 20-gage galvanized iron pan is placed over the entire top. A drawer is provided for tools and one of the uprights is fitted with a shelf for holding chucks, spring collars, etc. The countershaft and jack shaft are carried in the manner indicated, by the uprights. These latter are jointed between the cross cleat and the top to enable them to be taken down for shipment. The countershaft has an improved belt-shifting arrangement, the control being by means of the three small handles at the back of the lathe, while if preferred the rods can be extended below the bench and connected with foot treadles. The countershaft also carries pulleys in the proper position to be used with the milling attachment which fits the bench lathe. The 1¼-inch gas pipes constituting the uprights are tied together in the manner shown, the rods being provided with right and left threads, and the acorn-shaped pieces which form the tops of the uprights are screwed on so that where desired fixtures can be attached and the top braced to the wall or ceiling. The pulley at the right-hand end of the jack shaft may be belted from a motor placed at the end of the bench or attached to the wall or floor. The lathe as represented is equipped with a quick release attachment which allows work to be removed or put into the chuck, without stopping the spindle. This attachment is shown in Fig. 2, and little is required in the way of explanation. It may be applied to the lathe in a moment, the only thing necessary being to take out the index pin and put it in the arm of the attachment to prevent it from turning around. The manufacturers of the equipment shown are Hardinge Bros., Chicago, Ill.

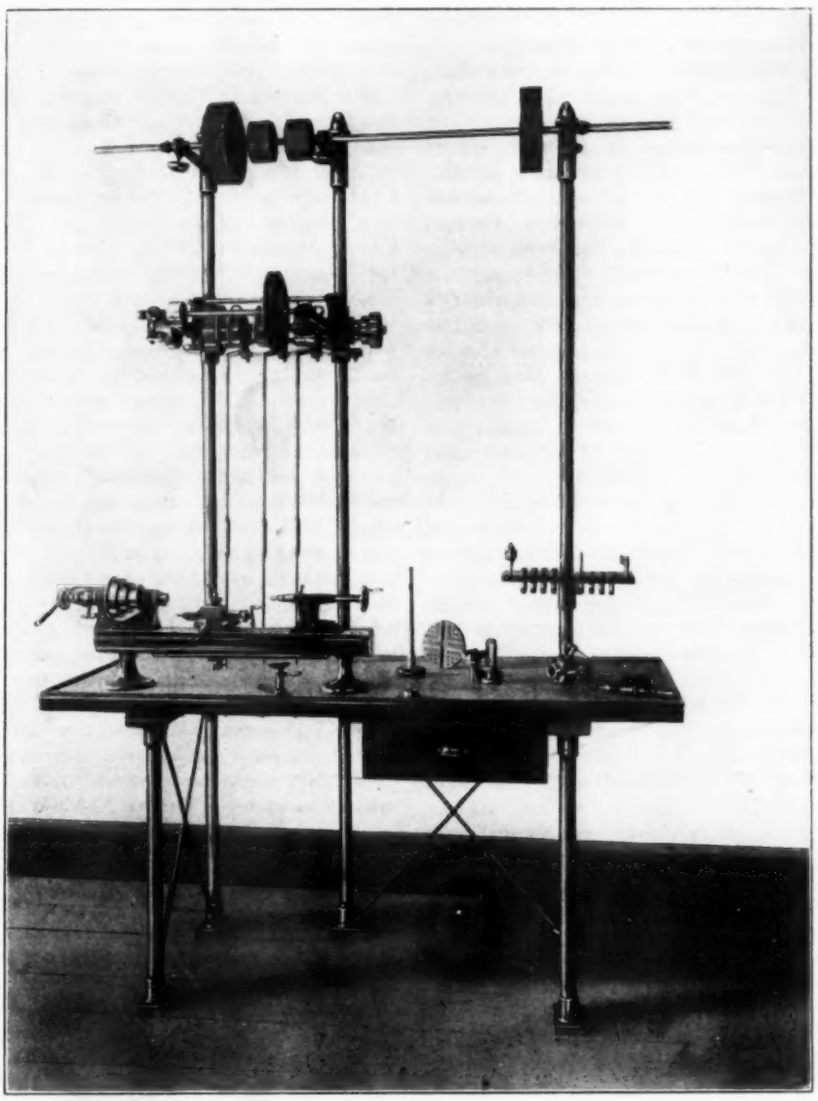


FIG. 1. GENERAL VIEW OF BENCH AND EQUIPMENT.

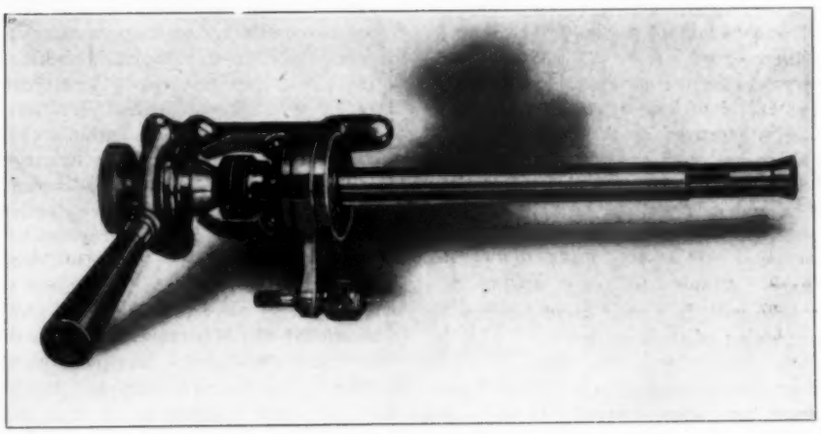


FIG. 2. QUICK RELEASE ATTACHMENT FOR BENCH LATHE.

Foreign Markets for American Machinery.

It will probably be useful information to your exporters dealing with the South African market to know that the rates previously charged for the conveyance between Cape Government Railroad stations of irrigation machinery and plant (viz.; 2d for imported and 3d for South African), will be applied in the future only when the consignment is accompanied by a declaration from the consignee or ultimate consignee, as the case may be, that the machinery or plant is actually to be used for irrigation purposes. If this is not done the higher rate will be charged in the first instance, viz.; 2d class for imported and 2 B class for South African; but a rebate will subsequently be granted of the difference on the production of a certificate as above.

It is interesting to note that the United States comes next to England in supplying British South Africa with machinery, tools, hardware, etc. For instance, during the six months ending December, 1905, the total value of mining machinery imported was £439,000, of which £292,000 was from England, and most of the £147,000 balance was of United States manufacture. In agricultural implements, of which £109,000

worth were imported, the United States sent most of the £64,000 of foreign origin, Great Britain contributed only to the value of £37,000. In hardware Belgium and the United States supplied not less value than £282,000 out of £799,000 received. In agricultural machinery England sent £20,000 and the United States nearly £17,000. Considering the very low freights ruling between the chief American ports and South Africa, your exporters have a decided advantage over British exporters, who frequently have to pay 30 per cent. more in freights from England than is charged from the United States, and that too, by British shipping companies. This question is being investigated, and it would be well for American exporters to take every advantage of the present favorable conditions, as it hardly seems possible for them to continue indefinitely. If this shipping preference remains many years, British exports to South Africa must grow less and less.

As there is every prospect of trade springing up in the Ottoman Empire, and in the Near East generally for machinery (especially oil engines, pumps, etc.) it would be well for United States exporters to take note of the conditions which go to insure success in those markets. They must remember that the right selection of an agent is most important and upon securing a man of commercial morality, business capacity and energy, everything depends. Every latitude should be given to the agent in respect to the terms of payment. The agent should also be encouraged to keep the manufacturer well supplied with designs of new machines, improvements, etc., put on the market by competitors. Wherever possible the manufacturer should sell directly to the consumer, through the local agent only. Prices should be quoted c.i.f. Constantinople, or other nearest principal city or port, and for this purpose manufacturers should themselves consider the question of freight. The two chief causes of dispute and non-payment of bills are: First, that goods were not to sample, and second, that they arrived too late. It is advisable that all orders should be taken in writing, signed by the customer, and addressed to the manufacturer by name. No shipment should be effected until everything is approved by the customer.

There has been an exceptional amount of trade done in Egypt during the last ten years, and it is perhaps as well to give a word of advice to exporters of tools and machinery. The great prosperity of the country during the past decade has brought with it a very large increase in the number of trade competitors, with the result that in order to obtain business prices from manufacturers and wholesale houses have been lowered and additional facilities given for payment. The native trader is perfectly well aware that if he breaks with one man there are a dozen more ready to do his business, and it is, consequently, only natural to find that agents are willing to stretch a point in the matter of credit rather than lose a good customer. Competition in very many directions is carried on to such an extent that some of the largest firms in the country—native and otherwise—are in such a position that they can refuse to sign drafts or—when goods are delivered from stocks in the chief towns—to give any acknowledgment beyond a simple receipt.

The engineering and tool trade, out of which large sums were made in past years, has felt the stress of competition very keenly and credits have increased accordingly. Formerly the terms in force were, say, one-third of the purchase money with the order, one-third after six months from delivery, and the remainder by a 12 months' bill. During the past five or six years these facilities have gradually grown until now the buyer has anywhere from 6 to 9 months in which to pay the second one-third, and from 12 to 18 months for the balance. Indeed, in some cases, payments are extended for as long as two years, but in such instances, interest from 7 per cent. to 9 per cent. is charged. The natives have, however, a great many objections to paying interest, it being contrary to the teaching of Mahomet to pay interest of any kind. It is very little use for firms to contemplate doing business in Egypt, unless they are prepared to conform to the present conditions and give credit. Of course, if they are able to correspond with a merchant who will buy outright, the case may be different, though profits will be smaller. It is quite essential to have first-class agents and allow them all reasonable latitude as regards granting credit. F. C. C.

London, England.

Francis William Webb.

Francis William Webb, for many years chief mechanical engineer of the London & North-Western Railway, and who died recently at Bournmouth, England, at the age of 71, entered the Crewe shops of the company as an apprentice in 1851 and upon the completion of his apprenticeship became assistant to Francis Trevithick, locomotive superintendent. Four years later he was appointed chief draftsman and in 1861 as Mr. Ramsbottom's chief assistant he became practically manager of the Crewe works. In this capacity he supervised many engineering undertakings, one of which was the construction of the bessemer-steel plant at Crewe. London *Engineering*, which contains an account of his career, states that his whole professional life with the exception of the years from 1866 to 1871 was spent in the service of the railroad company. During the five years referred to he was connected with the Bolton Iron and Steel Company. Soon after his return to Crewe in 1871 he was appointed chief mechanical engineer and held this position until his retirement from active service in 1903. Our contemporary gives the following particulars concerning Mr. Webb's connection with the development of the locomotive.

"Railway engineers knew him as a strong supporter of the compound locomotive. Soon after he had assumed the responsibility for the designing of the North-Western Railway engines, he took an old outside-cylinder Trevithick engine, reduced the diameter of one of its cylinders from 15 inches to 9 inches by means of a liner, and tried its behaviour as a compound of the Mallet type. The results were so far favorable that he built the 'Experiment' in 1881, the first of the famous three-cylinder compound type which Mr. Webb devised and supported so strongly. This engine had a pair of small leading wheels and two pairs of driving wheels, the second pair of the latter being driven by two outside high-pressure cylinders, and the front pair by a single low-pressure cylinder beneath the smoke-box. A drive on all four wheels was thus obtained without the use of coupling-rods. The 'Experiment' was followed by others of substantially the same type; but though the design was ingenious and possessed certain advantages, the criticism it met with, on the whole, proved justified, and the three-cylinder type is no longer considered advisable. However, for some time after its introduction it had considerable vogue.

"In 1885 there were about 50 three-cylinder compounds on the North-Western Railway, and Mr. Webb's system was introduced on some of the railways of France, Austria, India and several of the South American States. Up till 1893 the three-cylinder compound was used by Mr. Webb for passenger traffic, but in that year he designed a three-cylinder compound class with eight-coupled wheels for goods traffic, of which engines over eighty were put into service. Four years later he adopted four cylinders, the 'Black Prince,' the first of this type, being put into service in August, 1897. The four-cylinder type was designed for fast and heavy passenger service, the engine having to take the Scotch sleeping-saloon expresses from London to Crewe without a stop.

"One of Mr. Webb's most famous engines was the 'Charles Dickens,' a four-coupled locomotive with leading radial wheels. It was built in 1882 for express passenger service, and by the year 1903 had run two million miles, and had hauled no less than 5312 express trains between London and Manchester."

Mr. Webb was a member of many engineering associations, was president of the Mechanics' Institute in Crewe and for two years was mayor of that city.

Two cases of broken steering gear are reported in a week in London. Bad ad. for the motor bus.

Export Mistakes.

There are two sides to every proposition, each side requiring consideration in order to arrive at a sure result. The subject of export is no exception. There is the optimistic side, dealing only with successes in foreign fields. There is also the other side, on which are found the failures, the mistakes and the miscarriages of preconceived plans. This latter side has heretofore received scant consideration.

He who has made mistakes has at least learned how to avoid them for the future and to that extent the experience cannot be regarded as a loss. The same is true of a business, and when that business assumes the proportions of a nation's export trade in machinery, it is necessary that these mistakes be considered and pointed out publicly in order to guard against repetition. The only objection to this might be the plea that such a confession could be used against the American exporter. This is the plea of weakness and not worth while. Take for instance the failure of an American condenser in Buenos Aires. This failure, due perhaps to local operating conditions, will embroider many a text by Buenos Aires importers of British and German condensers, and an evil will already have been accomplished. If on the other hand an open discussion of the matter will prevent a repetition of it, that discussion is worth while.

The writer of this article looked after the New York office of a machinery exporting house for a number of years. Frequently he received calls from reporters.

"Any news?"

"$175,000 worth of engines has been placed with the British Parsons Company because the American manufacturers would not guarantee their corliss engines for use with superheated steam."

"Anything else?"

"South Africa has passed a bill giving Great Britain a preferential duty of five per cent. and some large groups of mines down there have decided to confine all their purchases to English manufacturers until further notice."

"Oh, can't you tell us something interesting—something cheerful—something optimistic? Trade readers of our export notes like to think our export trade is striding forward over all opposition. It makes 'em feel good. Haven't you got anything comfortable and smiling?"

"Yes, here's a small shipment of gas furnaces to the London Mint, amounting to about $500."

The next morning column articles appeared under such scare heads as:

"WE COIN KING EDWARD'S GOLD."

The meat of the matter was given in two lines. The balance of the article consisted of smug and contented pattings on the back about our ability to take trade away from English manufacturers on their own ground.

Such things are wrong. They tend to create in the mind of the American manufacturer a feeling that he has only to lift his little finger for export business and it will come rushing toward him. If the rush fails to materialize he blames his export man, if he has one, his foreign agents, the commission houses and the writers of his export advertisements. Nine times out of ten, the fault in his own goods.

Some years ago a large shipment of a standard make of American water-tube boilers was made for export. When they arrived at their destination, not one of them passed the test. Water leaked from them as from a sieve. The local firm of importers who had paid for the goods at New York was forced out of business. A special report on the subject was read by every Board of Trade in England which had boiler manufacturers among its members. The manufacturer of that particular shipment of boilers had evidently thought that anything was good enough for export. This make of boiler is in large use in America, and gives satisfaction. But here was a big inquiry for boilers, export shipment, easy money, and thereby the export of American boilers fell back a peg or two and British manufacturers smilingly advanced.

Within the last few years the Consolidated Gold Fields of South Africa decided to change their style of head-gear from wood to steel. As every shaft sunk on the Fields has its own head-gear, it is evident that here was a good piece of business offering. A trial head-gear was ordered in Great Britain, one in Germany, and one in the United States. Each of these was from the same tracing and the three competing countries were told that upon the strength of the trial orders the main order would be awarded. In the first place the American delivery terms were violated and the other two head-gears were in place when the American shipment reached Johannesburg. The mine was obliged to make $2500 worth of repairs and changes before the American gear could be passed upon. The other two (all three, it being remembered, being from the same tracing) went together without a hitch or a dollar's worth of changes. The result is that for some time to come, at least, the South African market is lost to American designers and builders of steel head-gears.

The moral is this: Goods made for export must be made conscientiously and carefully. Specifications must be followed. Proper tests must be made. Goods must be heavily boxed. And above all the American manufacturer must lose the silly notion that the foreigner is crying for his goods no matter how poorly they may be made. The foreigner is doing no such thing. On the contrary, salesmen from every manufacturing country in the world are whispering in his ear the warning that the "Yankee must be closely watched;" and when an American piece of machinery is erected abroad, the erection will generally be surveyed by a select coterie of British and German agents who will be ready to laugh right heartily if hitches occur in putting the machinery together or if the written points of guarantee are not verified by the machine itself.—*Power.*

Remington Typewriter Bonus.

The seventh half-yearly distribution of the bonus to the most efficient employees of over ten years' standing at the Remington typewriter factories took place in the Recreation Park of Wyckoff, Seamans & Benedict, at Ilion, N. Y., recently. The number participating—262—was the largest since the scheme was instituted and $13,100 in gold was divided, giving $50 to each person. A similar distribution takes place every Christmas.

The following are the periods of continuous employment represented in the recent occasion:

Three men over 33 years, six men over 25 years, thirty-four men over 20 years, ninety men over 15 years and one hundred twenty-nine men over 10 years.

At the same time a photograph of the bonus group was obtained and the prizes and certificates for good suggestions adopted during the past six months were presented.

There was a field day and outing for the entire factory force in which there was a general good time for everybody.

Metric System in England.

According to our "Daily Consular reports" "the Manchester Chamber of Commerce, like some other representative English bodies, has unanimously adopted a resolution with regard to the compulsory use of the metric system of weights and measures, which is intended to embody their policy henceforth with regard to this proposed legislation. The resolution is to the following effect: 'That, while continuing to support the enforced adoption of the metric system of weights and measures for general purposes in this country, the chamber shall always maintain, in any future action taken in support of legislation to bring this about, that the cotton-yarn trade and the engineering trades ought to be expressly exempt from such legislation.' The chamber declared that any legislation which failed to recognize the exceptions desired should be met by strenuous opposition from the great industries concerned."

This we take to mean that the Manchester Chamber of Commerce favors the compulsory use of the metric system in England by all industries except those in which Manchester is especially engaged. Fine spirit that!

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Shop Accidents.

A recent issue of a newspaper published in Connecticut contained accounts of three fatal accidents of like character, which occurred in one day in factories located in that State, a workman in each instance having been caught and whirled around a rapidly rotating pulley, or line shaft. While no particulars were given as to whether the casualties were due to carelessness on the part of the victims themselves or caused by negligence on the part of others in leaving unguarded dangerously located belts, pulleys and setscrews, there is no question but that workmen in machine shops and factories generally are quite apt to take altogether too many chances when working around machinery in operation.

Millwrights and repairmen whose work necessarily takes them aloft among the running shafting and pulleys, are particularly apt to become insensible to the possibility of being caught and injured and it is a matter of general observation that they are inclined to thoughtlessly assume unnecessary risks in keeping overhead apparatus in running order, though sometimes the blame for accidents they meet with must be placed on other shoulders. The writer recalls distinctly the customary methods of these men in a certain large manufacturing establishment, where he was one time employed and where owing to the fact that nearly the whole establishment was driven from one engine, nobody liked to assume the responsibility of having the whole plant tied up while some overhead repair job was going on; consequently it was not an uncommon thing for wide, heavy belts to be run off their pulleys, taken up and put back on the pulleys with the main shaft running at full speed. The writer once saw in the department where he worked three men put a tight, six-inch belt on a 36-inch pulley, running at 150 revolutions and was told by the men that that establishment was never expected to stop during working hours, unless the engine broke down or someone was caught in the machinery. As a result of this policy, the millwrights put belts on "on the fly" and where countershaft belts were wound up and were cut loose to prevent the counter being pulled down, the belt coiled on the line shaft was removed without stopping the shaft by one of the men holding a belt shipper against the wound-up belting while the other man caught the free end, dragged it down as far as possible and cut it off. This process repeated a half dozen times removed the belt, but it was a dangerous performance and anything but pleasant to witness.

Shortly after one of these exhibitions of recklessness in the department referred to, one of the same group of men while performing some similar operation in another section of the works was caught in the shafting, whirled around a number of times and thrown to the floor with injuries which kept him in the hospital for many weeks.

A peculiar accident of this type occurred some time ago in a New England shop, and, as stated by a friend who witnessed the affair, the principal in the occurrence escaped with much slighter injuries than one of the men who undertook to help him out of his predicament. While oiling a shaft which was located at some distance below the ceiling, the man's jumper was caught by the shaft and he was whirled rapidly round, although swinging clear of the overhead beams at each turn. A fellow-workman, however, who started to run to the engine room was struck in the face by the heels of the man on the shaft and beside losing several teeth, was knocked senseless and in fact laid up for several days. Upon the machinery being stopped and the man released it was discovered that he had received no further damage than a bad fright, a few bruises and a severe shaking up in general.

The courts have made such decisions in these matters as to constitute an insufficient influence toward the provision of safety devices. Men who value their jobs will take risks by conforming to the custom of the place in which they work. In Europe generally lives of workmen are much better protected than here and we ought to improve.

The New Secretary of the American Society of Mechanical Engineers.

Some time ago we announced that Calvin W. Rice had been invited by the council of the A. S. M. E., to become its secretary next December, upon the retirement of Professor Hutton from that position. We are now enabled to state that Mr. Rice has accepted the position, and in the meantime will, as assistant to Professor Hutton, familiarize himself with the work of the society.

The new secretary is still young in years, but has had considerable experience in various lines of engineering work.

He is a graduate in engineering from the Massachusetts Institute of Technology, and has had experience in machine shop practice, having worked up from the bench through the positions of foreman, draftsman, office engineering, and district engineer of the central States. He was for several years installing and operating complete steam, hydraulic, and electric plants in Colorado and Montana, and for several years was electrical engineer of the subways of the city of New York, and of the operating departments of the New York Edison Company. For the last three years, he has been consulting engineer for the New York office of the General Electric Company, making a specialty of the steam turbine and engaged in the engineering work connected with all manner of prospective propositions.

Mr. Rice is a member of the American

Institute of Electrical Engineers, American Society of Mechanical Engineers, the Institution of Electrical Engineers of Great Britain (having been proposed by Lord Kelvin), and a member of the American Association for the Advancement of Science.

As a result of a very careful canvass by a special committee, and by the council of the society, the choice finally fell upon Mr. Rice, as a result of the conviction that he is admirably adapted to carrying on the work.

As chairman of the Society's meetings Committee he has successfully done work of a nature similar to that which will devolve upon him as secretary, and in an official position with the Institute of Electrical Engineers he also developed uncommon ability for the doing of society work. Those who know him best feel most sure that Mr. Rice will be entirely successful.

Though Mr. Rice does not by any means credit himself with the possession of all the qualifications imputed to him by his friends, and has in no way sought the position, he is certain to go into the work with enthusiasm and in the full belief that with the co-operation of the members generally he will be successful in it.

The society is indebted to the management of the General Electric Company in this connection, for it happened that Mr. Rice had quite recently signed a contract with the company for two years' service, and the company by no means wished to lose him. It would have opposed his leaving to go into the service of any other private company, but relinquished its claims upon him in favor of the society, and in order that he might be enabled to render this service to the profession of mechanical engineering.

Some Modern Steamships.

Most of our readers are, of course, more or less interested in the development of trans-atlantic steamers, of which some half-dozen or more have been completed in the last 12 months, each notable in some respect or other. The most striking illustrations of the progress made in steamships for passenger service are to be seen in the sister ships "Lusitania," and the "Mauretania" now building for the Cunard Company. The first of these was launched from the Clydebank yards of John Brown & Co., June 7, and it is expected that she will enter the North Atlantic service early next year. These ships are popularly spoken of as "800-footers" although to be accurate, the length over all is 785 feet; the breadth is 88 feet, and the displacement 38,000 tons. The four screws of each ship are to be driven by turbine engines and are expected to give a speed of 25 knots.

It is interesting to compare these enormous and powerful ships with the first vessels operated by this company. Of the four paddle-wheel steamers with which the Cunard people entered the Atlantic trade in 1840, the "Britannia" is perhaps the one most frequently referred to, this having been, in fact, as many of our readers will recall, the vessel in which Charles Dickens made his voyage to America in 1842, and which he described somewhat at length in his "American Notes." These first Cunarders were a little over 200 feet long, of 34 feet beam, and the capacity of their engines is stated to have been 700 horse-power. The speed was 8½ knots, or practically one-third of the speed for which the new liners are designed. To attain the rate of 25 knots called for in the contracts for these ships the turbines have been constructed for about 70,000 horse-power or almost double that of the engines in the "Kaiser Wilhelm II," of the North German Lloyd fleet.

The "Lusitania" will be equipped with 25 steam boilers and it is estimated that she will require at least 5000 tons of coal to steam across the Atlantic; it is expected the trip will be made in about 4½ days. The old "Britannia" got along with something like 600 tons of fuel for the period of 14 or 15 days, which she required in making the passage; the steam pressure for that 1100-ton vessel was less than 10 pounds per square inch.

"You're another" is generally regarded as a very poor way of replying to a charge, particularly when said charge has been proved, as has been the case with the charges brought against the Chicago meat packers. However, many persons will probably derive some comfort from the fact that similar conditions have been unearthed in London, which again only shows that after all human nature is very much the same, whether we take it in Chicago, in London, Berlin, or St. Petersburg. The fact is, that it has simply been again demonstrated that where men prepare food to be consumed by others whom they do not know, and for whom they have no regard, human nature cannot be trusted to resist the temptation to use things which are objectionable, poisonous, filthy, or all three together. The fact that such doings have been unearthed in London may have some effect in checking the croaking against American business methods in general, much of which is, of course, entirely undeserved, whatever the Chicago packers may themselves deserve.

New Publications.

"The Phantom of the Poles," By William Reed. 283 5½x7¾-inch pages with numerous illustrations. Walter S. Rockey Company, New York. Price $1.50.

This is a book which deserves a notice only to warn book buyers from wasting the amount of money involved in buying it. The object of the author is to prove the earth to be hollow with an opening at each pole, into which he believes navigators have repeatedly sailed without knowing it! He discusses subjects of which he knows nothing and imagines things which are understood perfectly to be profound mysteries to which he is supplying the key, while the connection between his premises and conclusions is beyond the understanding of anyone but himself.

"Das Skizzieren von Maschinenteilen in Perspektive," by Carl Volk. Second and revised edition. Berlin, Julius Springer, 1906. Thirty-three 5½x8 11/16-inch pages; 60 sketches printed in the text; Cloth. Price 1.40 marks.

This little book has such a practical appearance as to cause one to regret that there is not more of it. It does not go deeply into the mathematics of perspective, but seeks rather to impart a practical view of the matter, such as many draftsmen acquire by experience. The examples pass from simple forms to more complex, including among the latter "transition forms," such as where a cylindrical cross-section enlarges and runs into a rectangular cross-section. Sectional perspective views and the solution of constructive problems are considered in later chapters. The sketches are clear and business-like, being largely of mechanical details.

"Labor Problem vs. Dividends," by T. S. Laughlin. Sixteen 5x7½-inch pages. Pendulum Print, East Greenwich, R. I.

The author of this pamphlet shows in a very striking manner how the multiplication table gets in its work in causing small sums per day to accumulate into large ones during a year. Assuming, for example, the case of a corporation of $50,000 capital stock and employing 200 men at an average of $3.00 per day and making no profits, he shows that the company could be made to earn 6 per cent. on its capital were the product of each employee to be increased by five cents per day. Similarly he shows how strikingly small improvements in the equipment increase and how small losses of time destroy dividends, and how small a profit per dollar's worth of work and per man employed are sufficient in the aggregate to pay dividends. To those who have not made similar calculations for themselves these results will be very impressive.

The high price of tin has caused many brass founders to add antimony to some bronze mixtures in order to reduce their cost. Spelter has also been used, but this does not have a good effect upon the color. The following is a good mixture where stiffness and a good color are required: Copper, 88 per cent.; zinc, 5.5 per cent.; tin, 2.75 per cent.; lead, 2.25 per cent.; antimony, 1.5 per cent.

New Tools and Machine Shop Appliances.

BENCH LATHE.

This lathe has a hardened and ground spindle 1 3/16 inches in diameter, with straight bearings and a ball thrust bearing. The spindle has a 12-degree taper mouth for spring collets and small step chucks, and the outside is ground to a standard taper for taking large step chucks, closers, face-plates, etc. The bushings, which are tapered on the outside, are split, and

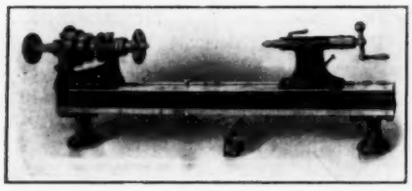


FIG. 1. BENCH LATHE.

have a square thread on the small end, providing for adjustment for wear. By this means the bearings can be easily adjusted and are kept always in alinement. End thrust is taken between a ball-thrust collar, set firmly in the front of the head and the shoulder on the front end of the spindle. End play is taken up by the nut shown, which is threaded to the front end of the head casting, and which takes a bearing against the front side of the spindle shoulder. This arrangement leaves the rear end of the spindle free to expand or contract with changes of temperature without affecting the end adjustment. It will be noticed also from Fig. 1 that the nut forms a dust cap for the front bearings. The cone pulley has two rows of index holes with 60 and 72 holes respectively, and the stop pin is brought into line with either row by an eccentric bushing. The lathe bed is 36 inches long, and the swing between centers is 20 inches; the swing over the bed being 8 inches. The slide rest, as shown in Fig.

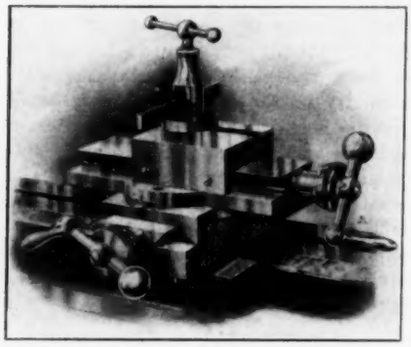


FIG. 2. SLIDE REST FOR BENCH LATHE.

2, consists of two slides and a swivel which is graduated in degrees. The bottom slide is provided with an adjustable stop, which comes in contact with the front of the bed, and brings the slide at right angles with the ways. The tool-steel screws run in ground bearings, and are provided with friction dials which read to thousandths, and can be set at any desired point for convenience of reading. The milling fixture, shown in Fig. 3, is fitted with longitudinal, cross and vertical slides, and with the necessary swivels, making it a universal attachment. The spindle is hardened and ground, takes the same size chuck as used in the head-spindle, and the back end is arranged to receive the index plate. The bottom or cross-slide has a movement of 4½ inches, is fitted with adjustable stop; and the screws like those used in the slide rest, are provided with friction, micrometer dials. The swivels are graduated as indicated, and the one which receives the spindle is fitted also with a sliding spindle, which carries a center for supporting the outer end of long, slim work. A universal live spindle-head is also made to go in place of the chuck spindle-head shown, and as it can be used at any angle, it is

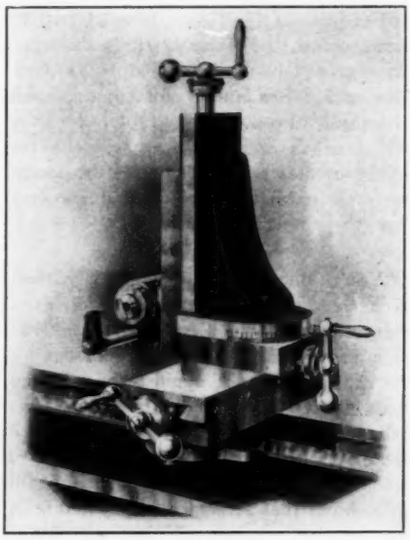


FIG. 3. MILLING ATTACHMENT FOR BENCH LATHE.

especially valuable on small tool or instrument work where angular milling or grinding is to be done. The universal head is driven from a regular grinding counter overhead. B. C. Ames & Co., Waltham, Mass., are the makers of this lathe.

A LUBRICATOR FOR GAS AND GASOLENE ENGINE CYLINDERS.

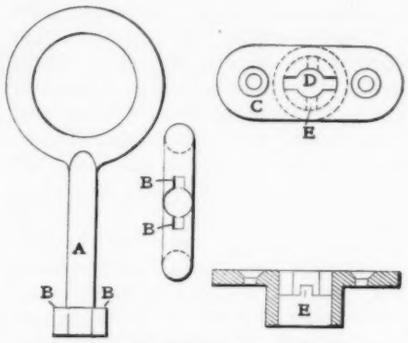
A sight feed lubricator for this purpose has recently been brought out. Where it screws into the cylinder it is provided with a ball check valve and a little farther up a baffling cap is inserted, these two prevent the back pressure from spattering the oil on the sight-feed glass. Valves are provided so that the flow of oil may be regulated and the lubricator filled while the engine is running.

The filling cap is seated on a lead washer, which, while practically indestructible, is easily renewed if necessary.

These lubricators are made by the Lunkenheimer Company, Cincinnati, Ohio.

A RAPPING-PLATE AND DRAW-IRON.

The draw-iron *A* has two lugs *B* formed on its end as shown. The rapping-plate has a hole *D* which allows the end of *A* to be inserted. When *A* has been entered in *D* it is turned a quarter turn so that the lugs *B* engage the notches *E* on the underside of *D*. These lugs and notches prevent the draw-iron from becoming accidentally detached, when the pattern is being drawn from the sand. There is no



THE RAPPING-PLATE AND DRAW-IRON.

necessity for detaching the crane hooks or using swivels on the hooks when using this draw-iron and rapping-plate, as a quarter turn attaches or detaches them. This is not the case with threaded draw-irons and rapping-plates. These articles are made by J. F. Dawe, 512 W. 5th street, Erie, Penn.

A DOUBLE-HEAD DISK GRINDER.

The illustration shows a double-head disk grinder, carrying disks 20 inches diameter and less. The spindles run in bushings fitted to the head castings.

These bushings are of gray iron, unless specially ordered of other material. It has been found in practice that cast-iron bushings lubricated with grease give the

A DOUBLE-HEAD DISK GRINDER.

best results in these machines. The head to the left is stationary, but the one to the right can be moved along the bed and clamped at any position the work demands.

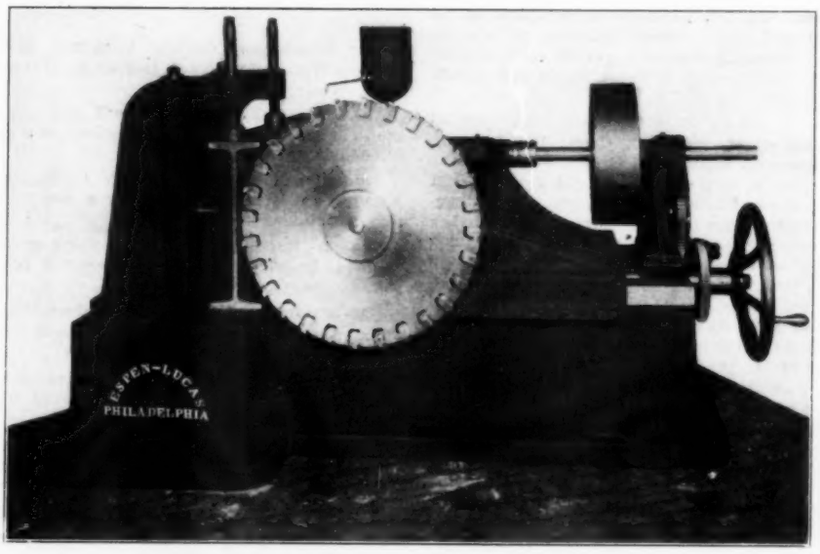
The spindle of the right-hand head has a longitudinal movement of one inch by lever and pinion engaging a rack cut on

the bushing. The bushings move with the spindle, and in this way there is no chance for emery or dirt to work into the spindle-bearing as would be the case if the spindle itself were slid in and out. The short movement of the spindle insures it being well supported, even when out at the extreme of its movement. Work from 0 to 20 inches wide can be ground. Either or both heads may be easily removed from the bed. Jigs or fixtures for special work may be clamped to the T-slot in front of the machine. An adjustable micrometer stop is provided so that work may be brought to exact size and duplicated. As the grease used flows from the center outward it prevents dirt from working in.

This machine is built by Chas. H. Besly & Co., 15 to 21 S. Clinton street, Chicago.

COLD SAW CUTTING-OFF MACHINE.

A structural-iron cold saw cutting-off machine is shown in the half-tone with the swiveled clamps in position for making a straight cut; the clamps can also be swung around so as to saw the beam at an angle of 45 degrees. The machine is



COLD SAW CUTTING-OFF MACHINE.

shown with a high-speed steel inserted-tooth saw blade, but may be furnished with a solid-plate high-speed steel saw blade, and it is geared to drive these saw blades up to their utmost capacity by means of a hardened crucible-steel worm and phosphor-bronze worm wheel through heavy gears made of hammered crucible-steel cut from the solid. The feed is variable and automatic, and can be increased or decreased at the will of the operator while the machine is cutting. An automatic stop will throw out the feed at any desired depth of cut. The capacity of this machine is 20-inch I-beams or 9-inch solid bars; floor space occupied 80x40 inches. Weight 7000 pounds. It is made by the Espen-Lucas Machine Works, Broad and Noble streets, Philadelphia, Penn.

Water Meters—Commission on Weights and Measures—Postal Notes.

Bulletin No. 21 of the Merchants' Association of New York is a summary of recent work accomplished, and we note among other things that the Association has had in its employ for some time past James H. Fuertes, C. E., who has been making an exhaustive study of the subject of waste of city water and its reduction by meters. Mr. Fuertes' investigation has extended to the experience of other cities, as well as that of New York, and his conclusion is that if the city will place at its own expense meters upon all the service pipes of the city, it will result in a net saving of from twenty to thirty million dollars, by postponing the date at which an extension of the water system will become necessary.

The Association has also taken some action with regard to the charges and the business of express and sleeping-car companies, as coming within the provisions of the Interstate Commerce Act, and has adopted strong resolutions, condemning present conditions, copies of which were sent to the Greater New York Delegation in Congress.

The Association was represented by Henry R. Towne before the House of Representatives Committee on Coinage, Weights and Measures, considering the subject of the metric bill, and the Association has drafted a bill which provides for a Commission on Weights and Measures, comprising from nine to fifteen commissioners, to be selected from various professions and pursuits, particularly scientific, industrial, agricultural, commercial, mechanical and maritime; said commission to investigate and to report to Congress upon the subject of measures of length, weight and volume in use throughout the United States and in other countries, in order to enable Congress to decide what action, if any, is feasible and expedient for the improvement of the system of weights and measures now in use in the United States.

The Association has also favored the issue of postal notes of all denominations for the purpose of facilitating the remittance of small sums through the mails. This is the bill which is being so strenuously opposed by some of our contemporaries and by hardware dealers' associations, on the ground that it will tend to facilitate the business of the so called "catalog houses;" in other words it will promote the free interchange of goods between the various localities and States of the Union.

The Association issues also a small leaflet, giving particulars regarding the rates of cab hire in New York City, with a statement of what the visitor to the city should do in case difficulty of any kind arises. This we understand is sent on application to anyone interested and who will write to the Association at 346 Broadway, New York.

The Bureau of Standards at Washington has issued "Bureau Circular No. 3," second edition, which supersedes the first edition, issued in 1903, and is devoted to an account of the verification of the standards of mass by the Bureau. To all those who have to do with accurate weighing, this circular will prove of decided interest.

Personal.

E. J. O'Hagan, superintendent of the Aerocar Company, of Detroit, Mich., has resigned to become general superintendent of the Ford Motor Company, of Detroit, Mich.

Hugh McDonald, a well known machinist, died at Williamsport, Penn., June 26, aged 54 years. He was prominent for nearly twenty years in business affairs in Williamsport, and was the inventor of various improvements in sewing machines and bicycles.

Howard D. MacDonald, who for several years has been connected with the Deering Works, International Harvester Company, Chicago, went to the J. I. Case Threshing Machine Company, of Racine, Wis., July 1 as chief draftsman of their tool designing department.

Walter Clarke Dean has opened offices in the Bank of Commerce Building, Norfolk, Va., and will represent the C & C Electric Company. Mr. Dean is a graduate of the Massachusetts Institute of Technology and has had considerable experience in the Equipment Department of the Norfolk Navy Yard, where he has made a specialty of variable-speed motors for driving machine tools.

Thomas B. Burnite, who until recently was connected with the engineering department of Charles C. Moore & Co., Engineers, San Francisco, is now with the John A. Traylor Machinery Company, manufacturers of and dealers in mining and milling machinery, Denver, Colorado. Mr. Burnite's work will be with the engineering and sales departments, and he took up his duties on June 20. Mr. Burnite is an occasional welcome contributor to our columns over the signature of "Bayard."

Business Items.

Hardinge Brothers, Lincoln avenue, Chicago, are constructing an addition to their factory which will afford about two-thirds more space than formerly occupied.

The firm of S. A. Risdon, Waterbury, Conn., will hereafter be known as the Risdon Tool Works. This company is in new quarters and will enlarge its equipment and output.

The machine shop of E. J. Bowers has removed from 3029 Chestnut street to 412-414 North Darien street, Philadelphia. The facilities of this company will be much greater in its new quarters.

Crocker-Wheeler Company, of Ampere, N. J., has recently sold the Wm. Cramp & Sons' Ship and Engine Company, of Philadelphia, Pa., eight 5½-kw. motor generators for the United States Navy gun-elevating equipments.

Barwood & Snider have opened an office at 367 Bourse Building, Philadelphia, Pa., for the sale of metal and wood-working machinery and tools. They have been appointed sales agents for the Geometric Tool Company.

The Buffalo Forge Company and Buffalo Steam Pump Company will abandon their office in Columbus, beginning July 1, locating in Cleveland and Cincinnati—A. J. Vance taking charge of their interests in the latter territory, W. A. Rowe having in hand the Cleveland district.

Wells Bros. & Co., Greenfield, Mass., manufacturers of Little Giant taps, screw plates, dies and machinery, are just erecting a new addition to their works, which will be of concrete construction, 85x112 feet, and be equipped with machinery for the manufacture of open die-bolt cutters and nut tappers.

Hardinge Brothers, Chicago, manufacturers of tools and machinery, are constructing an addition to their factory, increasing the capacity about two-thirds. They expect to have it completed about the middle of August. They have also just issued their new price list of their Cataract lathe and attachments.

Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, Ampere, N. J., sailed June 14 on the Lloyd steamship "Barbarossa" for a short European trip. He was accompanied by Francis B. Crocker, professor of electrical engineering at Columbia University, who has been assocated with him in business for many years.

The Niles-Bement-Pond and Pratt & Whitney companies will move out of their Boston offices and showroom at 144 Pearl street, July 1, taking up new quarters on the eighth floor of the Oliver Building. They propose to carry a general stock of machinery at their storehouse, but rely for their main source of supply on New York and Hartford.

The Hyatt Roller Bearing Company, Harrison, N. J., has just broken ground for a three-story addtion, 75x100, to be erected adjoining their present machine shop. Samue M. Green, of Holyoke, Mass., has prepared the plans. The new building will be ready for occupancy August 1, and by that time the company's output will be increased at least 50 per cent.

Application for a charter has been made to the Pennsylvania State authorities by the Westinghouse Consolidated Foundries Company, of Pittsburg, Pa. The object is for the various Westinghouse companies, which now have foundries at Pittsburg, Allegheny City, Cleveland, and Attica, N. Y., to have all their castings made in one factory, which is located at Trafford City, near Pittsburg. This plan is to assure greater economy and uniformity in the making of foundry products.

The Abner Doble Company announces that it has relocated its offices at its former site, Fremont and Howard streets, San Francisco. The company is one of the first to resume operations in the burned district and has taken contracts for a large amount of work in addition to the orders on hand previous to the fire. Work is progressing rapidly on the company's new shops and warehouses in the Potrero district, at Seventh and Hubbell streets. Temporary pattern and forge shops are already in operation on the new site..

The National Abrasive Company, of Bridgeport, Conn., has been incorporated and has purchased the business and plant of the American Corundum Company, of that city. It will manufacture abrasives and a line of emery wheels. The plant is located on the main line of the N. Y., N. H. & H. Railroad and there is a spur track running into the factory. George F. Reif is to be general manager. Mr. Reif was formerly president of the National Emery Wheel Company, of Worcester, Mass. He has had over 25 years' experience in the wheel business and is well known among the trade.

The Adams Tool Company, offices at 36 Pearl street, Hartford, Conn., has been incorporated, with a capital of $50,000, and the factory is located on the main road in East Hartford. Their initial installation of machine tools has been about completed and they propose to have facilities for employing 200 men later on. They intend to manufacture machinery, machinists' tools, do experimental, model, gauge, punch and die work, sheet-metal work and make hardware specialties. The officers of the company are: Harry A. Adams, president; Augustus F. Kummel, vice-president, and Francis H. Peabody, secretary and treasurer. Mr. Adams has had experience for many years in fine toolwork, manufacture of typewriters, etc. He will be assisted by A. L. Monrad, who has been engaged many years at model, punch and diework. Mr. Monrad will assist Mr. Adams in the management of the factory. Augustus F. Kummel was for many years with the Pratt & Whitney Company and is now with the Becker-Brainard Milling Machine Company, his duties with the Adams Tool Company being such that they do not conflict with those in connection with the Becker-Brainard Milling Machine Company. Francis H. Peabody is secretary and treasurer and has charge of the financial end of the business.

Manufacturers.

J. C. Cleveland, Storm Lake, Iowa, will erect a machine shop.

Plans are out for a power plant at Haverford College, Haverford, Pa.

The Mechanics' Machine Company, Rockford, Ill., will erect a new factory.

The Monroe (Mich.) Binders' Board Company has bought site for a factory.

The Warner Gas Fixture Company, Philadelphia, Pa., will erect a new plant.

John Mansley, Walker Building, Salt Lake City, Utah, will build a power plant.

The Hyatt Roller Bearing Company, Harrison, N J., will put up a $12,000 addition.

The Lincoln Stove and Range Company, Fremont, Ohio, will erect a new foundry.

The Tennessee Mantel Company, Knoxville, Tenn., is building an addition to its plant.

The Link-Belt Engineering Company, Nicetown, Pa., will make additions to its plant.

The plant of the Iroquois Portland Cement Company, Caledonia, N. Y., will be doubled.

The American Wringer Company, Woonsocket, R. I., will build a two-story addition.

The Remy Electric Company, Anderson, Ind., has let contract for new factory buildings.

The Laurel (Del.) Standard Barrel Company has been organized. S. H. Bacon, president.

The R. Haas Electric and Manufacturing Company, Springfield, Ill., is erecting a new plant.

The Bridgeport (Conn.) Malleable Iron Company is estimating on a large foundry addition.

Charles Zies, Baltimore, Md., will erect a three-story machine shop at 314-318 Fremont avenue.

R. J. Schwab, Sons & Co., Milwaukee, Wis., are erecting a four-story addition to their foundry.

The plant of the Cincinnati (Ohio) Screw and Tap Company will be moved to Epworth Heights.

The Grand Ledge (Mich.) Clay Product Company has been organized. E. A. Turnbull, president.

The Washington Cutlery Company, Milwaukee, Wis., will erect a factory at Watertown, Wis.

The Central of Georgia Railroad will erect shops in Macon, Ga., at an estimated cost of $1,000,000.

The Star Foundry Company, Covington, Ky., has taken out a permit for a new factory building.

The J. S. Thorn Company, sheet-metal workers, Philadelphia, Pa., will erect a new $30,000 plant.

The Manitowoc (Wis.) Clay Product Company, whose plant was recently burned, has started to rebuild.

The Radcliffe & Porter Manufacturing Company, Milwaukee, Wis., has plans ready for a new power house.

L. Lewith & Son, Wilkes-Barre, Pa., will erect a rectifying plant to be equipped with the latest machinery.

The Wallace Barnes Company, Bristol, Conn., which manufactures steel clock springs, will build an addition.

The Berthelet Sewer Pipe Company, Milwaukee, Wis., will erect a plant in Douglasdale, a suburb of that city.

An $18,000 factory for the manufacture of carriages and buggies is being erected for Alex. Fiegelson, Beaumont, Texas.

The Osborne & Stephenson Manufacturing Company, hardware specialties, Plainville, Conn., is enlarging its plant.

Plans have been completed by the Detroit & Toledo Shore Line for a new roundhouse and machine shops at Toledo, Ohio.

The W. P. Davis Machine Company, Rochester, N. Y., has made application for a permit to build another machine shop.

The Globe Silk Manufacturing Company has been organized at Scranton, Pa. Capital, $50,000. Henry J. Ziegler, Sr., president.

The Roxboro (N. C.) Cotton Mills will build a 10,000-spindle addition, which will represent an investment of about $200,000.

The candle factory of A. Gross & Co., Jersey City, N. J., which burned some time ago, is to be rebuilt at a cost of more than $100,000.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Wire and sheet metal working machinery and tools. Emmons Collins, Chicago, Ill.

Want copy of AMERICAN MACHINIST, No. 5, Vol. 28. Box 762, AMERICAN MACHINIST.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Electrical apparatus designed and built. Geo. M. Mayer, 1131 Monadnock Bl., Chicago, Ill.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—Work for an 84-inch Bickford boring mill; can furnish castings. Fulton Machine & Vise Co., Lowville, N. Y.

Special machinery to order. Catalog of small engines and boilers and engine castings, 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Wanted—To complete volume, AMERICAN MACHINIST of April 13, 1905. Will pay premium. Box 613, AMERICAN MACHINIST.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Wanted—To purchase machinery and shop equipment necessary for manufacturing balls for ball bearing. Address offers to D. 238, Annoncen Expedition of D. Schürmann, Düsseldorf, Germany.

Well known and old-established firm in Birmingham, England, doing business with all the large engineering works, is anxious to take up the sole agency for some specialty worth pushing. Highest references given. Box 780, AMERICAN MACHINIST.

Mechanical draftsman—On plant equipment and maintenance with a large manufacturing company; practical shop experience and a thorough knowledge of power transmission necessary. Engineering Agency, Monadnock Block, Chicago.

Specialties—We make on contract, specialties for marine, automobile and general use, and do general machine-shop work on small brass goods. Lovell-McConnell Mfg. Co., Currier Bldg., opp. Pennsylvania Railroad Station, Newark, N. J.

A manufacturing concern having one of the most modern and compete plants in Ohio for the manufacture of brass and iron specialties, including steam goods, solicits orders for special work in quantity lots. Address N. L. H., 172 West Locust street, Columbus, Ohio.

We build special machinery, tools, etc., for responsible parties at prices which well demonstrate our modern practice and facilities. Estimates gratis. Send drawing for our lowest bid. New Haven Tool and Machine Specialty Co., 456 Broad st., Bridgeport, Conn.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. **Book costs you nothing if you become a customer.** Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/5 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Co., 1036 Majestic Building, Detroit, Mich.

Machinist wanted in every machine shop in the country to handle "The Chip Fender," an ingenious device to protect the machinist from the hot chips flying from work on lathe or planer. Instantly applied to any shaped tool. Sells on sight. Every machinist wants one or more. Send 15c. for sample and liberal terms to agents. Edward L. Finn, 12 Clark street, Torrington, Conn.

For Sale.

For Sale—Excellent machine-shop building, with power, in Philadelphia; 60x90 feet, three stories, solid ground floor. Box 545, AM. M.

For Sale—Black glass test bars, 5/16x1½x7 inches long, $3.50; knife-edge squares and straight edges; all tools guaranteed. "Scotty," Box 765, AMERICAN MACHINIST.

For Sale—Foundry, machine and boiler shop, well equipped and in operation, in one of the best growing towns of Oregon; good opportunity for a competent manager of limited means to acquire a substantial interest. Box 761, AMERICAN MACHINIST.

Business Opportunities.

Wanted—Bid on some light manufacturing work, Eastern firm preferred; must be one who can guarantee delivery requiring at least five to ten men constantly working on contracts. Box 732, AMERICAN MACHINIST.

For Rent—Three-story brick and stone factory building with large brick manager's house and horse barn on grounds. Factory equipped with two 20 h.p. Smith turbine water wheels, two 11½ kw. Westinghouse D. C. generators. Fire protection on each floor. The most beautiful and healthful town in Pennsylvania. Cheap help—no manufacturing competition. Good railway and trolley facilities. Equipments all new, never used. Apply to T. A. Willson, Ephrata, Lancaster Co., Pa.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Engineer (English) seeks responsible position; 11 years' experience in H. M. Royal Navy; have had charge of erecting steam, electric and air-compressing machinery. Box 698, AMERICAN MACHINIST.

CONNECTICUT.

Position wanted by an experienced mechanic who can build special, new, improved machinery for valve manufacturing, and who is an expert in dies, fixtures, etc. Address P. O. Box 95, Bridgeport, Conn.

ILLINOIS.

Position wanted as engineer or superintendent of electric vehicle company by expert graduate engineer. Box 774, AMER. MACH.

Wanted — Superintendency or assistant, young hustling mechanic, familiar with modern methods, technically educated, practical experience, good executive, has responsible position, desires change; references. Address M. C. F., AMERICAN MACHINIST.

MARYLAND.

Mechanical engineer (employed at present), technical graduate, 10 years' experience in marine, automobile and general machine construction, desires position as engineer or assistant with contractor, consulting engineer or manufacturing company. Box 760, AM. M.

MASSACHUSETTS.

Mechanical draftsman, experienced toolmaker, designer of jigs, fixtures, automatic and special machinery, desires responsible position. Box 741, AMERICAN MACHINIST.

Draftsman wants work. Have had experience in gun, sewing machine, textile machinery, and tools and fixtures for manufacturing economical and interchangeable. Box 770, AMERICAN MACHINIST.

NEW YORK.

Production engineer, purchasing agent, cost accountant, familiar with premium system, 10 years' experience, good systematizer, desires change. Box 779, AMER. MACHINIST.

Position wanted by experienced superintendent and buyer: intricate work, rapid production, with interchangability, cost, stock, and tool systems. Box 773, AMERICAN MACHIN.

Toolmaker, first class, on jigs, fixtures, dies, capable of devising the same; varied experience in general manufacturing; have held several positions as foreman. Box 769, AMERICAN MACHINIST.

Wanted—Position in publicity department of manufacturing establishment in Eastern territory; experienced in the preparation of copy and with the details of cut making and printing. Box 681, AMERICAN MACHINIST.

Am now employed as designing draftsman, but wish to change location; American, with 13 years' experience in shop and office, part of the time in charge; not particular as to nature of position. Box 772, AM. MACHINIST.

OHIO.

Superintendent of small concern would like to correspond with parties in need of a good executive and up-to-date mechanic; have an elegant proposition and A-1 references; can invest; successful at producing first-class work at satisfactory cost. Box 763, AM. MACH.

PENNSYLVANIA.

Position wanted by superintendent boiler maker; experience on marine, stationary, locomotive and all classes of sheet-iron work. Box 764, AMERICAN MACHINIST.

Young progressive mechanical engineer, graduate, 10 years' practical experience, versed in modern shop methods, desires position as assistant chief engineer or superintendent. Box 777, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted—Foreman for toolroom in an automobile factory in Canada; must be an A-1 man, thoroughly accustomed to the most modern toolroom practices, accustomed to handling men, and one who is generally systematic in his work; permanent position to right man. In applying, please give experience, references and salary expected. Box 740, AM. M.

CONNECTICUT.

Wanted—Several competent all-around jobbing machinists. The Eastern Machinery Co., New Haven, Conn.

Good machinists wanted—Bench and lathe hands. Apply, stating age and experience, to The Boesch Mfg. Co., Danbury, Conn.

DISTRICT OF COLUMBIA.

Wanted—Master shipfitter (outside), $6 per diem. A competent examination will be held for the above position July 12, 1906. For further information address Commandant, Navy Yard, Portsmouth, N. H.

ILLINOIS.

Wanted, draftsmen — We want capable draftsmen of either electrical, mechanical or general experience. If you would like to change your position or its location, write and tell us about the character and extent of your work. Address, giving full particulars, to Western Electric Company, Dept. N. 29, Chicago.

INDIANA.

Wanted—Foreman for die-sinking and drop-forge work, experienced in both lines; give age, references, etc. Address "Automobile," Box 756, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Five or six good machinists for fine machine work. Apply to Union Twist Drill Co., Athol, Mass.

Wanted—One toolmaker, three machinists on auto work, and expert gear-cutting man. Box 738, AMERICAN MACHINIST.

MICHIGAN.

Machine-shop foreman—Wanted, a competent machinist to take charge of the die and tool-making department of a large factory; applicants must show actual experience as foreman and must have a thorough knowledge of die designing and drafting. Address Box 744, AMERICAN MACHINIST.

MINNESOTA.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

NEW JERSEY.

Wanted—Mechanical electrical draftsmen; only first-class men need apply. Box 508, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted—Foreman for foundry making machinery castings in dry and green sand, employing 15 molders. Must be competent and

reliable, know how to produce good castings at a minimum cost; permanent position if satisfactory. To insure answer, give full particulars, stating experience, references, age, salary desired. Communication may be considered confidential. Address Box 776, AM. M.

NEW YORK.

Toolmakers, first-class. Smith & Mabley Mfg. Co., 614 East 83d St., New York.

Draftsmen wanted for jig and fixture work. Appy Mergenthaler Linotype Company, 20-42 Ryerson street, Brooklyn.

Machinists—First-class machinists, vise and lathe hands, wanted. Smith & Mabley Mfg. Co., 614 East 83d St., New York.

Milling machine hands of experience wanted on duplicated parts. Mergenthaler Linotype Co., 20-42 Ryerson St., Brooklyn, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, refrences and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—First-class men as toolmakers on punches and dies, also light high-grade jig and fixture work. Remington Typewriter Factory, Ilion, N. Y.

Wanted—Two draftsmen on small electrical apparatus; must have had shop experience, preferably at tool work. Address Box 778, AMERICAN MACHINIST.

Wanted—At once, one toolmaker and one foreman for machine room in factory running 20 to 30 men; in applying, state experience and wages expected. Box 771, AM. M.

Wanted—First-class foreman for machine shop; must be able to handle men and produce work, also fairly versed in modern shop practice; give references. Address P. O. Box 73, Buffalo, N. Y.

We are permanently increasing our capacity and require the services of 10 mechanical draftsmen for detail work; attractive positions to suitable men; location, New York City. Address, stating age, experience and salary expected, Box 748, AM. MACHINIST.

Assistant superintendent wanted—A young man with a technical education and experience in directing the manufacture of small interchangeable parts; good organizer; thorough knowledge of tools and modern machine-shop methods; excellent opportunity with rapidly developing business; state age, nationality, experience and expectations. Correspondence confidential. Producer, Box 768, AMERICAN MACHINIST.

OHIO.

Wanted—High-grade machinist for engine work. S. M. Jones Company, Toledo, Ohio.

Several diesinkers, toolmakers and machinists. The P. A. Geier Co., 50 High St., Cleveland, O.

Several first-class draftsmen on detail and assembly drawings; state age, experience and salary. Box 746, AMERICAN MACHINIST.

Three or four competent mechanical draftsmen. In replying, give full information, including rate expected. Box 686, AM. MACH.

Wanted—First-class mechanic with $2000 to superintend an established lathe manufacturing company in Cincinnati; grand opportunity. Z, Box 775, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Foreman wanted to look after 50 to 75 men in a department of a large machine shop equipped with medium-size tools; must be up-to-date and a hustler; state age, experience and salary. Address Box 766, AM. MACH.

Good draftsmen with experience in designing, by a machine tool concern in Cincinnati. One familiar with radial drills and screw and turret machinery preferred. Excellent future. State age, salary, experience and address Box 23, Sta. B, Cincinnati, O.

PENNSYLVANIA.

Wanted—Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A few first-class machinists and toolmakers; also one or two automatic screw-machine operators for automobile work; steady work guaranteed. Address, giving experience, references and wages desired, The Autocar Company, Ardmore, Pa.

Draftsman wanted—One who has had experience in designing tool-grinding machines and fixtures for same; must be capable of following work through shop and then go on the road demonstrating and selling machines; good salary to capable man. Apply box 767, AMERICAN MACHINIST.

Wanted—A first-class man as general foreman of our brass department on brass globe, angle and gate valves, and a general line of steam goods. Factory located in western Pennsylvania. To the right party we have a good position to offer. State age and experience. Address Box 692, AMER. MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filed. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Pierce Mfg. Co., Woonsocket, R. I.

TENNESSEE.

Wanted—Several first-class lathe hands; open shop; steady employment and good wages to competent men. Apply Duke-Success Machine Works, Memphis, Tenn.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., of Milwaukee, needs more patternmakers, machinists and moulders.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

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Star Corundum Wheel Co., Detroit, Mich.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alloy, Nickel

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.

Ball Bearings

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Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
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Barrels, Tumbling

Globe Machine and Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Eng. Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Bars, Boring Cylinder

Underwood & Co., H. B., Philadelphia, Pa.

Belt Dressing

Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Montgomery & Co., New York.
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Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Wm., Phila., Pa.
Toledo Mch. & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

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Watson-Stillman Co., New York.

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Bertsch & Co., Cambridge City, Ind.
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National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers & Co., Wm., Phila., Pa.
Swaine Co., Fred J., St. Louis, Mo.

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Wallace Supply Co., Chicago, Ill.

Bicycle Parts

Standard Welding Co., Cleveland, Ohio.

Blanks, Nut and Screw

Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

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Am. Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.

Blowers—*Continued.*
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Blue Print Machines
Buckeye Engine Co., Salem, O.
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Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery
Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., Easthampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
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Lang Co., G. R., Cincinnati, O.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Webster & Perks Tool Co., Springfield, O.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bolts and Nuts
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Mechanical
American School of Correspondence, Chicago, Ill.
Henley Pub. Co., Norman W., New York.
Hill Pub. Co., New York.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters
Burke Electric Co., Erie, Pa.
C & C Elec. Co., New York.
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Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley-G. I. Elec. Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
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Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.

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Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. Tool Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills
American Tool Wks., Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
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Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boxes, Tote
Cleveland Wire Spring Co., Cleveland, O.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brazing Plates
Phillips-Laffitte Co., Phila., Pa.

Broker, Machinery
Warner, C. S., Niagara Falls, Ont.

Bulldozers
Bertram & Sons Co., Ltd., Dundas, Ontario, Canada.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Toledo Mch. & Tool Co., Toledo, Ohio.

Burners, Oil
Tate, Jones & Co., Pittsburg, Pa.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.

Calipers
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Smith Co., Ernst G., Columbia, Pa.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Works, Boston, Mass.

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Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fuchs & Lang Mfg. Co., New York.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
U. S. Foundry & Sales Co., South Norwalk, Conn.

Castings, Motor
Brush & Hudson, Brooklyn, N. Y.
Harrison, H. K., St. Paul, Minn.
Steffey Mfg. Co., Phila., Pa.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
National Mach. Co., The, Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mahine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Boston, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield Mass.
Horton & Son Co., The E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
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Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Horton & Son Co., The E., Windsor Locks, Conn.
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Oneida Natl. Chuck Co., Oneida, N. Y.
Scott & Sons Co., Medford, Mass.
Skinner Chuck Co., New Britain, Conn.
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Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
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Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
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Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.

Clutches, Friction
American Tool & Mach. Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V. Phila., Pa.
Double Friction Coil Clutch Co., Chicago, Ill.
Double Friction Coil Clutch Co., Chicago, Ill.
Eastern Mach. Co., New Haven, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
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Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

Coils
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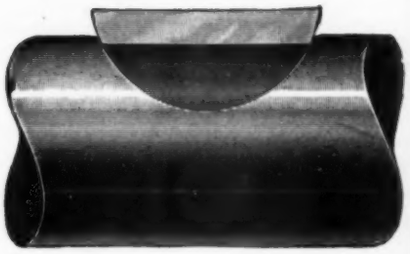

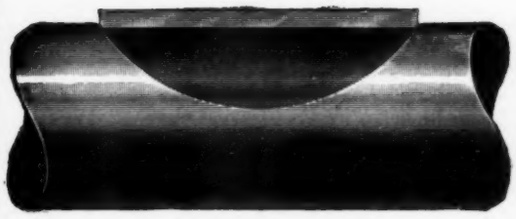

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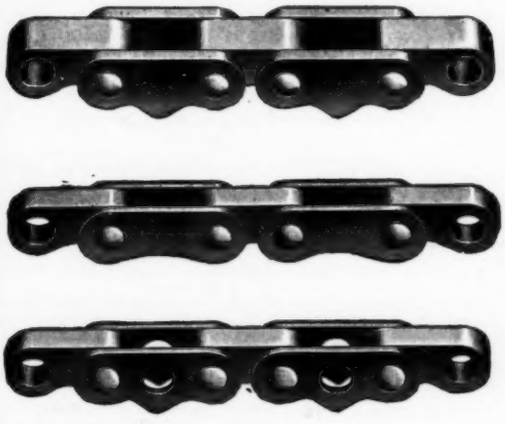

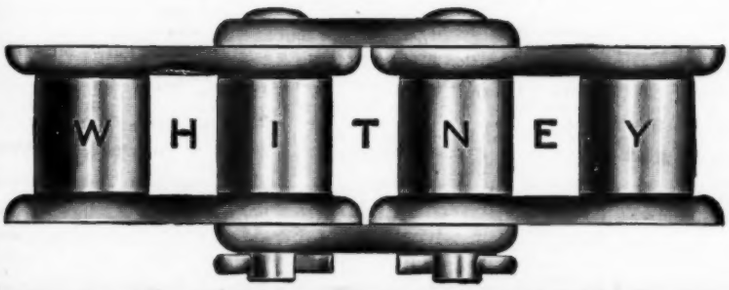

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Pattern Mounting on the Molding Machine.

BY F. W. HALL.

The recent strike of the core-makers and molders in Philadelphia has caused several foundrymen to install molding machines and others to think very seriously about doing so. With many of them the great difficulty is to obtain a man who understands the mounting of patterns on the machine; this job usually falls into the hands of the patternmaker, though sometimes it is given to a machinist. The patternmaker's knowledge of the foundry and patterns in general makes him the best man for the job, but as a rule patternmakers are rather handicapped on account of their lack of knowledge of the running of machine tools, such as planers, lathes and milling machines, but with assistance rendered by the machine shop they do very well.

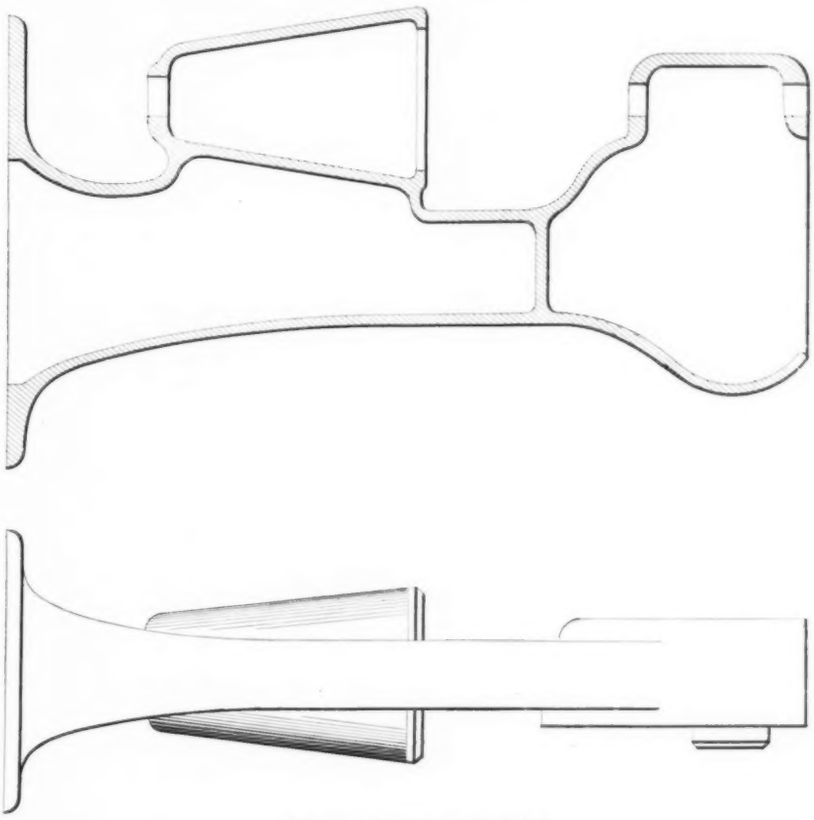


FIG. 1. CASTING TO BE MADE.

The patternmaker is sometimes blamed for unsatisfactory results when the real cause is that the proprietor has not purchased the proper type of machine for his class of work; the patternmaker having nothing to do with the purchasing of the machines, does the best he can in mounting the pattern on the one which has been provided, but the work does not come out right. The patternmaker is also liable to meet with other obstacles, such as the personal dislike of the boss molder, and the aversion of the latter to having molding machines in his shop, though he may not openly oppose them and may, in the presence of the proprietor, show himself willing to try the machines; but he has many opportunities to hinder the success of the machine, and he is liable to do so when the proprietor's back is turned. In order to attain success it is necessary that the boss molder and the patternmaker should work together toward this result, for there is certain knowledge of the foundry which can be best supplied by the molder, and in like manner the foundryman has not got the knowledge of the machines and the patterns that the patternmaker has. Therefore the proprietor should see to it that the relations between the two are harmonious.

IRON FLASKS.

The flask question is a rock upon which the spirit of harmony sometimes splits. It may be that the foundry foreman wants to use iron flasks, and the success with which they meet in many foundries which use nothing else leads the proprietor to order iron flasks.

The foundryman has good reasons for desiring to have them. They make it unnecessary to put weights and boxes on the mold before pouring it, so when his work is poured at night he will have very little scrap lying around on the floor and a greater percentage of the castings will be good ones. When the molds are made in snap flasks and boxes are put on them, and they are weighted before pouring, it frequently happens that in spite of the boxes the molds will burst out, and thus the boxes will be burned until they are out of shape, if not entirely destroyed; sometimes in setting the boxes on the molds they will go on hard, and the molds will be crushed, which destruction is completed by the setting of the weight on top of it. The molder knows these things, whereas the patternmaker may not fully realize the damage resulting in such ways. The boss foundryman's aim, which of course is correct, is to turn out less scrap and more perfect castings; while the aim of the patternmaker is to turn out as many molds per day as possible, and if the results are not satisfactory he will lay the blame on the boss foundryman or on the molders. My experience has been that there are jobs which should be made in iron flasks because the snap flask is now so large that any further enlargement will make it too heavy for the molders to handle. Then again, very often smaller flasks which have sand boxes put on them could just as well be made a little larger and thus do away with the necessity for the boxes. A good practice of many foundrymen is to put iron bands in the molds before ramming them up. In small foundries where they have no cranes nor air hoists it is all right to use wooden flasks, but in larger foundries well equipped with carrying devices they should be able to use iron flasks to advantage. The machine operator merely makes the molds, while separate gangs take them away and at night take out the flasks and pile them up handy for the machine men in the morning. The exact arrangement of affairs should, of course, be governed by circumstances.

MOUNTING PATTERNS ON MOLDING MACHINES.

The same principle applies to the mounting of patterns on machines; of the numerous ways, some are cheaper than others, and frequently one method will turn out the mold as perfect as another, yet the latter method in the long run will stand up the best and will give the better satisfaction. The job which forms the basis of this article was one of those jobs which was first mounted the cheapest way, and was afterward changed over to a much better way in order to increase the output of the machine. The first way was so flimsy that after a few molds had been made, the strippers got out of shape and did not return to the correct position, so the job was returned to the pattern shop for reconstruction. In spite of the greater expense of the latter way, it paid for itself in a short time.

Fig. 1 represents the casting to be made.

Fig. 2 is an elevation of the molding machine, with the drag pattern mounted on it, and also shows the flask, sand and bottom board, in place.

Fig. 3 is a plan of Fig. 2 minus the strippers and flask, showing the relative position of the pattern and the cross bars *D*, with the opening of the flask frame *J*.

Fig. 4 is a plan of the drag portion of the pattern with the cross-bars connected to the core prints *E* and *F* of the pattern *A*.

Fig. 5 is a plan of the core board by which the three cores are accurately set in the mold by an unskilled boy.

Fig. 6 is an elevation partly in section, showing the core board with a drag mold setting in place on top of it with the cores in place.

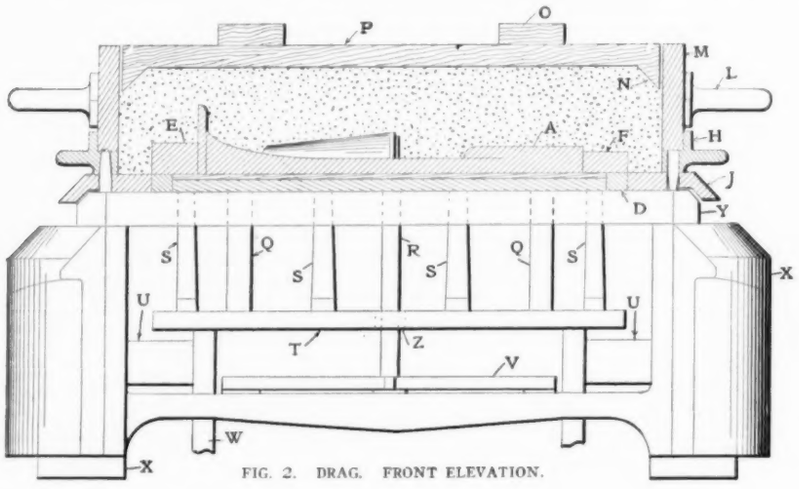


FIG. 2. DRAG. FRONT ELEVATION.

This job was mounted on a Paxson-Hall molding machine of the double-table type, in which the swinging ramming head mounted above the flask did the ramming for both tables. The first time the pattern was mounted on the machine thin sheet-brass strippers about ⅛ inch thick were made to the shape of the pattern and the outer edge of the pattern plate, and as the pattern was split in the center and worked on the bench for a long time, the edges got somewhat worn out of shape, so ⅛-inch sheet brass was fastened to the under side of each half of the pattern, and the edges were filled up with solder in order to stop up all the cracks; then the pattern plate which fits in the top frame *J*, and comes flush with it, was planed down ⅛ inch thinner to offset the ⅛ inch put on the bottom of the patterns. The ⅛-inch stripper was then made to fit the remaining ⅛-inch space on top of the pattern plate, and through the pattern plates where the two strippers set were drilled three 5/16-inch holes clear through; these were for the stools that were fastened to the sheet-brass strippers and extended down to the stool plate below. When a mold was made and the pattern stripped, little particles of sand would drop down under the brass strippers and prevent the strippers from going back to their proper places, making it necessary that the strippers be raised again, and the particles of sand blown out of the way; this meant delay which affected the daily output of the machine. To prevent all the trouble the job was reconstructed in the manner illustrated, which I will describe more fully.

THE IMPROVED METHOD OF MOUNTING.

Starting with the half patterns found in the foundry, we had a pattern to the shape of the casting shown in Fig. 1 with a core print added to each end of it, there being three separate cores to the one casting; the thickness of the casting was anywhere from 3/16 in. to ¼ in. In mounting the pattern the second time, ¾-in. sheet brass was used and was cut to the same shape as the pattern and pattern-plate, as was done the first time; then the pattern-plate was separated into three parts by scribing the outline on its upper surface and drilling ⅛-in. holes in the plate along the scribed outline of the pattern, as close to one another as possible; then the plate was broken through the holes and the rough edges of the plates filed off, so as to be smaller than the pattern. The pattern was then fastened to the pattern plate and the strippers to the remaining section of the pattern plate, thus strengthening the sheet brass and leaving no place for loose particles of sand to fall on and prevent the strippers from coming to their proper location. The pattern plate has a screw hole at each corner for connecting it to the pattern-rapping device. It becomes necessary, now that the pattern plate is made into three separate sections, to connect the center section to the pattern-rapping device; in order to do this without changing the location of the binding screws, two cross-bars ¾ in. square, and long enough to extend from one side of the opening in plate *J* to the other side, thus covering the two binding screws *G*, were fastened to the under side of the core prints *F* and *E*, Fig. 4, in which the cross-bar is designated as *D*. This cross-bar comes to the top face of the plate *J*; on each end of the strippers, ¾ in. is cut off so as to offset the ¾-in. cross-bar setting at each end of the pattern. The stools for supporting the stripping plates in position alongside of the pattern are designated by *S* in Fig. 2; a wood pattern was made for them and the necessary finish was allowed on the top and bottom, the length of the stool being governed by the distance of the stool plate from the bottom of the strippers when set in place alongside of the pattern *A*. Eight castings were made from this stool pattern, and were shaped to the correct length and set in place, four to each stripper, as will be seen in the drawings. As the stripper is of itself very stiff and there is no danger of its springing, only one of the stools was fastened down to the stool plate, just enough to make sure that the stool and stripper would return to their proper places when yoke *W* returned to its lowest position. The pattern *A* being much lighter through its center than in any other part, and the pattern plate upon which it sets in the first way of mounting having been cut into three separate parts, thus leaving the pattern *A* and the section of the pattern plate upon which it sets much weaker, to offset this and to stiffen up the pattern in the center so as to prevent it from springing when the rammer was applied to the mold, a stud *R*, Fig. 2, was set in the auxiliary stool plate *V*, directly under the center or weak part of

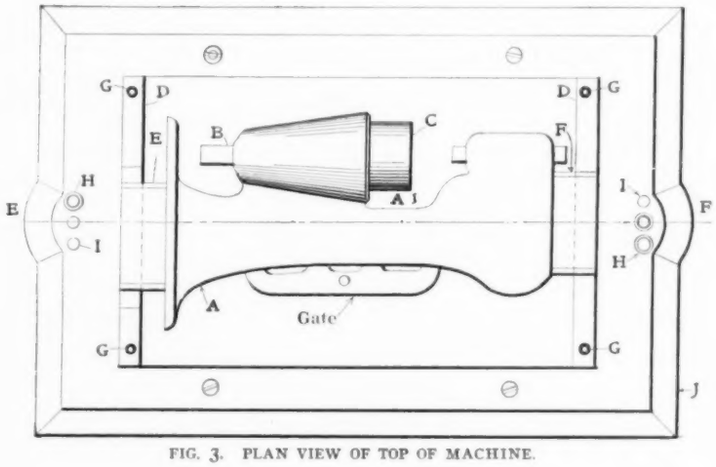


FIG. 3. PLAN VIEW OF TOP OF MACHINE.

the pattern *A*. This stool *R* passes through a hole drilled in the stool plate *T* and designated as *Z*. It will be seen that the stool *R* will prevent any spring of the pattern.

THE COPE.

The cope pattern is similar to the drag except for two small bosses not shown in the plan of the casting; in the mounting of the cope pattern on the cope molding machine a similar method is resorted to, stools being used to support the pattern

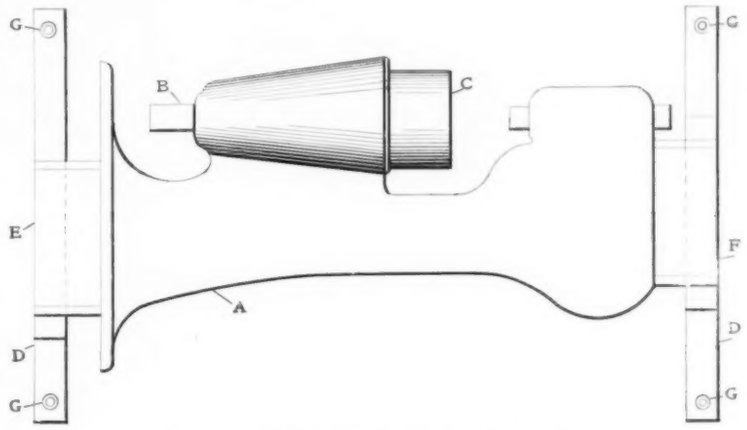


FIG. 4. DRAG PATTERN AND CROSS-BAR D.

strippers, while a center stool *R* is used to support the pattern in the center.

LAYING OUT.

In locating this pattern on the Paxson-Hall machine, as shown in the cut, a center line *E F*, Fig. 3, is scribed across the pattern plate. This line, as will be seen, comes directly in between *H* and *I* at either end of the flask frame *J*. The holes *H* and *I*, as well as the center hole, are located in the flask frame by means of a jig, which sets in the finishing opening of the flask frame *J*. A similar center line is then scribed across the center of the under side of the patttern *A*, this center being governed by the shape of the pattern. To decide where this line will come, the pattern is laid on the top of the machine and a flask is set on the machine; or, if no flask is to be had, then its outline is drawn on the top of the flask frame *J*. Then, with the pattern setting within the flask in the position most advantageous for molding and pouring, a line is laid off on the end of the pattern just half way between each side and the end of the flask, determining the center line; then put the halves of the pattern together and from the center line, which was scribed on one section, locate the one on the other section, thus insuring the accuracy of the job so far as the center line goes. As the pattern plate is machined very true to fit the opening in the flask frame, only a few thousandths of an inch of play being allowed, and the holes in the flask frames being located by a true jig, it is possible to easily locate a center line on the cope and drag-pattern plates that will be true with the flask pins, as the flask pins will govern the matching of the sections of the mold when closed.

THE RAPPING DEVICE.

For rapping the pattern so as to prevent the sand from sticking to it a special device is furnished on the machine, and from it extend four studs directly under the four holes *G* in the end of the cross-bars *D* of Fig. 3; in the center of the four studs is tapped a hole for the screw that goes in the hole *G* of the cross-bar *D* of Fig. 3. The rapping-device frame is made fast to the back of the machine and supported in front on two steel supports, thus making it possible to move enough to take up all play allowed in the pattern plate and flask frame. To this special rapping device in front of the machine is fastened a patented rapping engine worked by compressed air. This rapping device is not shown, as it would make the drawing somewhat confusing. Both cope and drag machines are equipped the same and are controlled by a three-way valve at the side of the machine, within reach of the operator as he stands in front of it.

THE FLASK.

The flask for this job is a well-made snap flask 14x25 inches, with a 5½-inch cope and a 6-inch drag; these flasks are made a little deeper than a regular hand-rammed flask, the extra depth being for a sand frame to hold the sand in its loose state. Bottom boards are used with a tucker (*N*, Fig. 2) all around the edges, *O* being the battens on the board against which the rammer comes when ramming the board in the mold.

There is nothing difficult in molding this pattern, as it is quite flat, the worst point being *A*-1 of Fig. 3, which is so small a body of sand that it will stick down if nothing be done to prevent it; a nail is, therefore, set in the mold at that point to secure it. A gate is fastened to one of the strippers close up to the pattern, as shown in Fig. 3.

THE CORE BOARD.

The core work for this mold is the most bothersome, as the cores have to be anchored; when skilled molders are employed the work is done well, though it is a little slow; but when unskilled men are operating the machine, these cores are very difficult for them to place, and it takes much longer to set them than to make the mold. To offset this a core board was resorted to, which is shown in plan in Fig. 5; it is very similar to a match board. It is a frame a little deeper than half the diameter of the largest core, having a bottom board made fast by screws, the object of the board being to hold the cores in their proper locations.

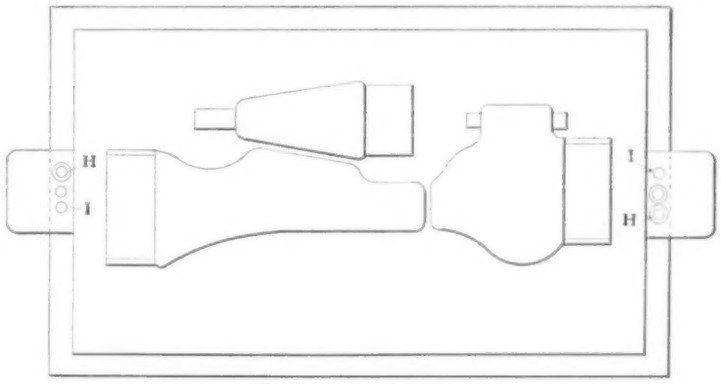


FIG. 5 Plan of Core Board

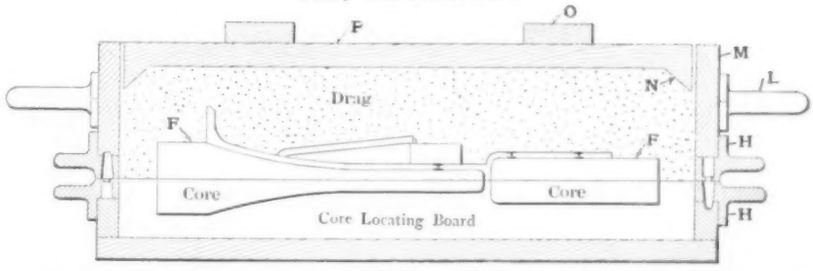


FIG. 6. ELEVATION, PARTLY SECTION, SHOWING COREBOARD WITH CORES, AND DRAG MOLD.

The following is the method of making the core board: The core frame has irons set in it at each end for the flask pins

and drilled by a jig as was the flask, and the flask pins go into the holes, making it the same as the cope section of the flask. A drag section of the mold is made, and the cores are accurately set in the desired positions, then the cavity all around the cores is filled up and slicked off true with the remaining flat surface and the core frame is then put on, the pins in the holes in the drag section of the flask securing it. A mess of plaster of paris is mixed and poured into the top of the frame all over the core and top of the drag mold until the whole frame is full, then the bottom board is screwed down tight and left there until the plaster sets. The sand mold is then lifted off and the plaster is cleaned free of all dirt that may have stayed down. It is well to give the plaster a coat of shellac; when dry the core frame is ready for use.

A boy can be used to set the cores in the core frame; on the part that must be secured a heavy tin chaplet is placed; when the operator makes the drag section of the mold, it is lifted off the machine and closed down on the top of the core board; then the whole affair is rolled over, the core board is lifted off and the cope of the mold is then made. Meanwhile the boy is placing the tin chaplet on the top of the core in the drag section of the mold; and then he sets the cores in the core board for a new mold, and in the meantime the operator has made the cope and closes it down on the drag. This method insures that the cores will always be set in the mold in the one location, and it is not necessary for the operator to leave his machine standing still while he does it, since it is only the work of a boy, who in time can learn to become a valuable machine operator.

In Fig. 6 is shown the drag mold setting on the core board with the cores in place; *M* is the drag flask and *L* the lifting handles on the end of it; *H* being the iron parts in the end of the flask and frame for the flask pins to fit into.

THE ACTION WHEN DRAWING THE PATTERN.

As compressed air is applied to the lower part of yoke *W*, Fig. 2, by means of the three-way valve at the side of the machine, the yoke *W* will rise up, and as plate *T* and posts *Q* are attached to the yoke and on top of the posts *Q* rests the flask frame *J* which in turn supports the flask *M*, the rising of the yoke will bring about the drawing of the sand away from the pattern, and the strippers being attached to the plate *T* will also rise, thus stripping the pattern and preventing the sand from sticking around the sides of the pattern. In this upward movement of the frame *J*, the stripping of the flask pins will also be accomplished as the pins are made fast to a frame under the frame *J*. When the mold has been lifted off the machine, the air is exhausted through the three-way valve and the yoke and all parts drop to their normal position ready for another mold.

Molding a Heavy Balance Wheel.

There are probably very few wood patternmakers who have never had any experience in making patterns for large pulleys and balance wheels, but the accompanying article may have a few points of interest and profit for all. Fig. 1 shows the plan, elevation and partial cross-section of a balance wheel. It is in halves, the hub being bolted together and the rim bolted and keyed.

Now, for the benefit of those who do not possess much practical knowledge of patterns or patternmaking, I might say that it is not customary to make full patterns for work of this kind for the reasons that the molding would be rendered more difficult, and the cost of the pattern would be greatly increased. The usual practice is to make a segment of the rim, of convenient length, and to connect it with a central point in such a way as to allow of its being moved around as it is rammed up. The arms are made in cores from a half core-box, and a full pattern is made for the hub, having a hole through it to allow of its being slipped over the shaft center. A sweep is required to strike the bed for the arm cores and rim, and a skeleton core-box for the cakes which cover the rim and hub. A half box is also needed to core out the hub and to split it.

These few remarks apply to large wheels in general; but the additional points about this job are—the notches around the face of the rim, used for turning the crank over the center, and the recess and slots in the rim where it is bolted, used for keying the rim together and taking the strain off the bolts.

We first made a pattern for a section of the rim, Fig. 2; in this case about one-sixth of the circumference in length, boxing it up in the usual manner and making provision for the rapping and draw plates. The facing strip *A* is put on the cope as well as on the drag side, to give the molder a guide for sweeping the bed for the cope cakes. Next, the gage sticks *B* are made, being pinned and screwed to the segment and cut out on the other end to fit against the upright shaft that is fixed into the center of the pit in which the pattern is to be molded.

To make the lug on the inside of the rim, shown in Fig. 1 and at *C* in Fig. 2: A piece about six or seven inches longer than the lug was fitted against the rim, the extra length being for prints for bolt-hole cores. The projecting part *D*, Fig. 2, is a print for the core which forms the round corner on the cope side of the lug, the core-box for this being shown in Fig. 4.

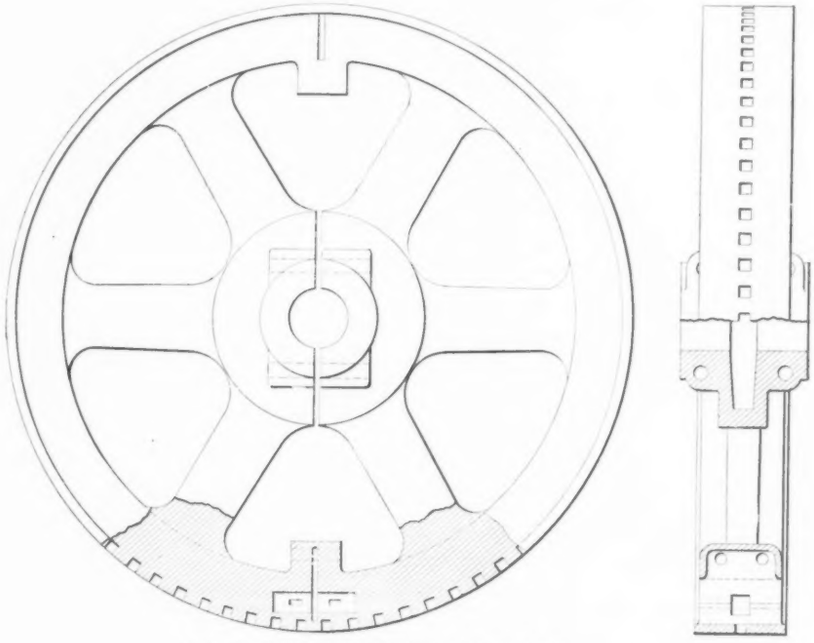


FIG. 1. FLY-WHEEL CASTING TO BE MADE.

For the notches on the rim, we made a print *E*, Fig. 2, held in place on the pattern by removable pins. You will notice that this print is not square, but is beveled off both on the top and on the outside. The bevel on the top is to allow the core to tighten up in its print, and that on the outside is for the benefit of the core-box, shown in Fig. 3. This core is made of a convenient length for handling, and divided equally around the circle. To save turning the box over when making the core, it is left open top and bottom, and the sweep *F* bevels the top.

A half core-box for the bolt-holes in the lug is shown in plan *U* and sections *VV* and *WW*, in Fig. 5. This box is so arranged that by the use of loose pieces, both halves of the core may be made. As will be seen, a part of the splitter core is attached to the bolt cores, shown also in Fig. 7.

We will now consider the core for the recess and slots, and the remainder of the splitter. The slots are small compared to the size of the recess, so, in order to make a stronger core we joined the slot in the print on both cope and drag and also printed the splitter part on both sides. The drag print is shown pinned to the segment at *J*, Fig. 2; that for the cope cake at *K*, Fig. 6. Fig. 8 shows a plan *X*, and sections *YY* and *ZZ* of the core-box, which is

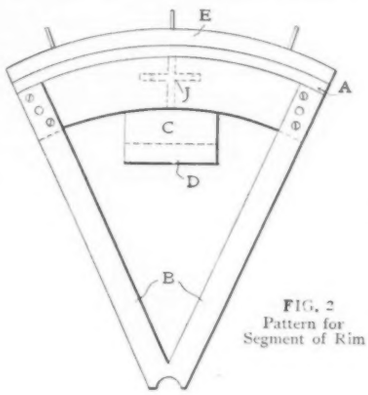


FIG. 2
Pattern for Segment of Rim

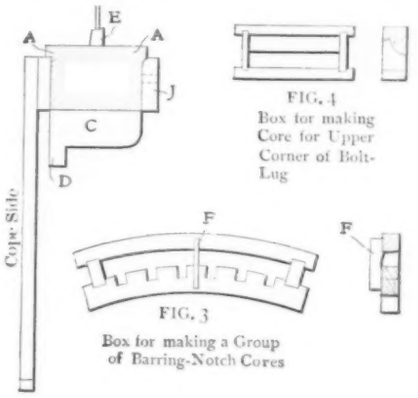
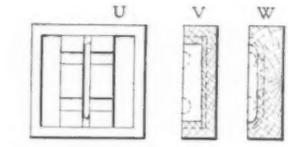


FIG. 4
Box for making Core for Upper Corner of Bolt-Lug

FIG. 3
Box for making a Group of Barring-Notch Cores



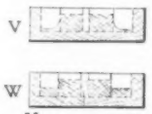


FIG. 5
Core-Box for Lug Bolt-Holes and portion of Splitter Core
V as arranged to make half away from hub
W " " " " toward hub

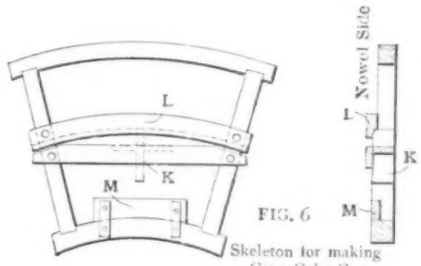
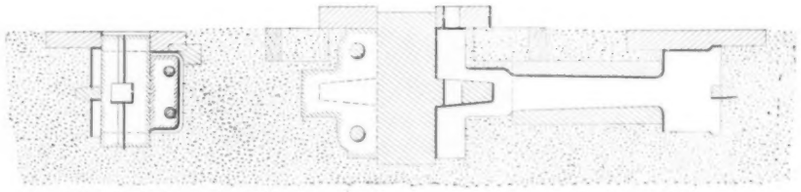
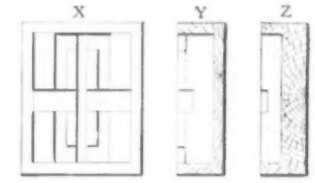


FIG. 6
Skeleton for making Cope Cake Cores



Cross-Section of Mold through Splitters — Cross-Section through Arm

FIG. 7. SECTIONS OF MOLD.



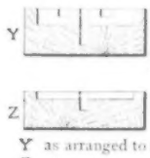


FIG. 8
Core-Box for Prisoner-Recess and Key-Slots, and remainder of Splitter
Y as arranged to make half nearest hub
Z " " " " away from hub

FIG. 9
Sweep Board for Bed of Mold

made so that all of the slot parts of the core will be on the one half.

Fig. 6 shows a plan and cross-section of the skeleton for the cope cakes. The flat side is made on the plate, thus avoiding the trouble of turning the core over when being made. Piece *L* forms the round corner. Piece *M* is put in to give clearance for the core shown in Fig. 4, also shown in Fig. 7. Pieces *K* and *M* are in on two cakes only, namely, those above the splitters. The sweep for the bed on which the arm cores and segments rest, is shown in Fig. 9.

All that now remains is a make-up for the facing strip *A*, Fig. 2, and a core-rod pattern for the cope cakes, neither of which are shown as they are common to all pulleys and balance wheels.

This method gave good results, as it insured the sure escape of the vent from the recess, slots and splitter core, right through the cope cake, this being the only part that might be liable to blow.

J. A. M.

Better Electric Lamps.

One would naturally suppose that anything which would tend toward the greater efficiency of electric lights would meet the favor of those who own and operate generating stations from which current is supplied for operating such lamps. In almost any line of business, it would be recognized, we think, by practically everyone, that such an increase of efficiency would inevitably lead to an increase of business, and would be a good thing for all concerned; especially where the business is carried on in competition with other lines. We infer, however, that this is not the case with the electric lighting business, our inference being based upon an argument which we find in the *Electrical World*, and which is evidently addressed to those who are disposed to look askance upon new lamps which have greatly increased efficiency. The argument of our contemporary is as follows:

Ever since the tantalum lamp appeared as a commercial illuminant of the immediate future central station men have been giving considerable thought to the policy to be adopted toward these new higher-efficiency incandescent lamps. Since the tantalum lamp first appeared the new graphitized (so-called metallized) carbon filament lamp has been put on the market in quantities. Now comes the introduction of high-efficiency carbon filament lamps in small units, soon to be followed by the introduction of the tantalum lamp on the American market. Assuming the technical performance of these new small high-efficiency units to be as stated by the manufacturers, some interesting questions come up for immediate solution by every central station company. Manufacturers have doubtless planned wisely in deciding to make lamps take the same watts as existing common incandescent lamps, but giving an increased light. The tendency will then be for customers to take more light and spend the same amount of money as before rather than to reduce bills without increasing their illumination. None but the narrowest-minded central station manager can fail to welcome increase of lamp efficiency, for every such increase puts in his hands the means of more successfully meeting the competition of gas, gasolene and kerosene. Whether they are welcome or not, they will have to be reckoned with, because if a central station company is unprogressive enough not to introduce a higher-efficiency illuminant, it will be placed on its lines by outsiders, for local dealers will soon learn of the higher efficiency obtainable and begin to market these lamps in every community, just as the Welsbach mantle was and is at present being sold.

The year 1905 was a prosperous one for the British Institution of Mechanical Engineers. The annual report of the Council shows that there are 9 honorary members, 2427 members, 1748 associate members, 72 associates and 494 graduates; total, 4750. The balance of revenue over expenditures was about $8000.

Collapsing Pressure of Bessemer Steel Lap-Welded Tubes Three to Ten Inches in Diameter—II.*

BY REID T. STEWART.

Charts of Actual and Calculated Collapsing Pressures—Figs. 4, 5 and 6 show a comparson of the results obtained by actual test with the corresponding calculated values, plotted to a vertical scale representing collapsing pressures in pounds per square inch, and a horizontal scale representing the thickness of wall in decimals of an inch. It will be noted that Fig. 4 is for the experimental tubes having outside diameters of 3, 6 and 10 inches, the diameter being written in each case on the margin at the right-hand end of the line representing the tube. Similarly, Figs. 5 and 6 were constructed for the tubes having outside diameters of respectively 4 and 7 inches, and 6⅝ and 8⅝ inches.

The lines on these charts were plotted from values calculated by means of formulas (*A*) and (*B*) representing the most probable values for the collapsing pressures of lap-welded bessemer steel tubes in lengths of 20 feet between transverse joints tending to hold the tube to a circular form. The center of each small circle lying on these lines represents a plotted calculated value.

The actual collapsing pressures of the different tubes tested, plotted to the same scales as the calculated values, are represented by crosses (+) for those having outside diameters of 3, 10, 4, 7 and 8⅝ inch, and by tees (T) for the 6 and the 6⅝ inch. In a number of instances, in order to avoid confusion, the characters being very close together, it became necessary to omit a part of the cross (+), in which case it became a tee (T), and likewise a part of the tee it thus

*Abstract of a paper read at the Chattanooga meeting of the American Society of Mechanical Engineers.

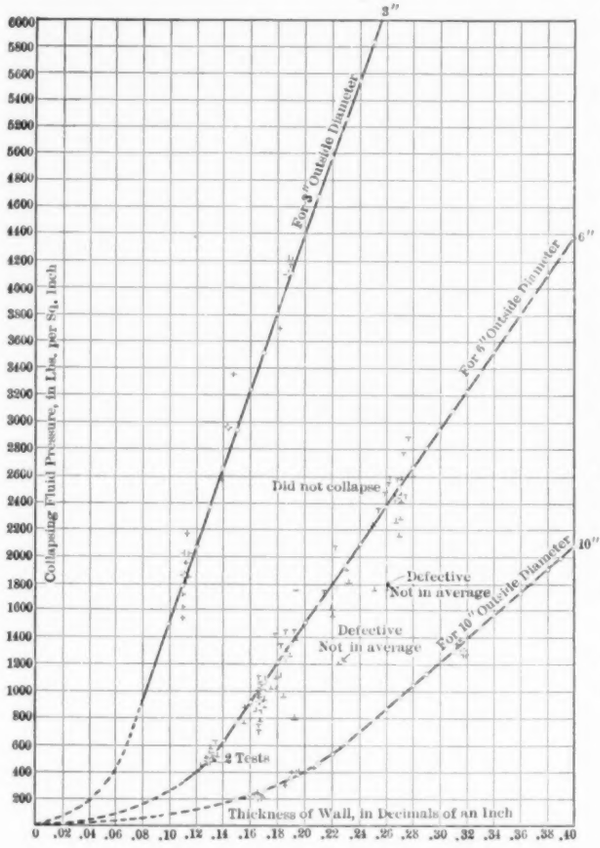


FIG. 4. 3, 6 AND 10 INCH TUBES.

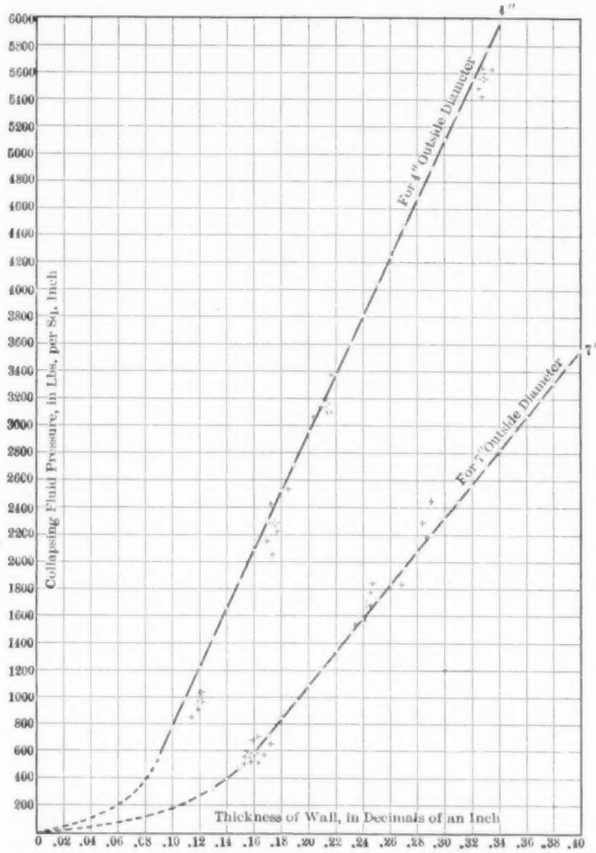

Collapsing Fluid Pressure, in Lbs. per Sq. Inch
Thickness of Wall, in Decimals of an Inch
For 4" Outside Diameter
For 7" Outside Diameter

FIG. 5. 4 AND 7 INCH TUBES.

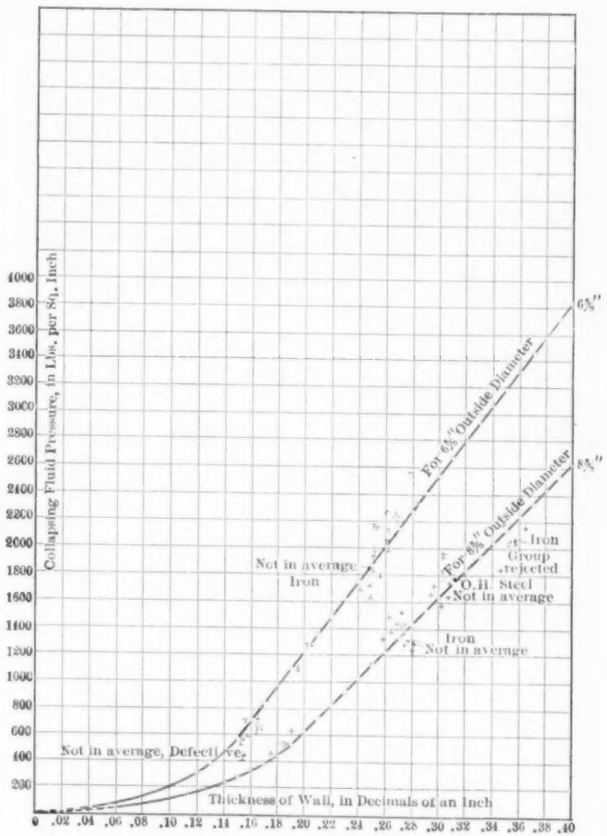


FIG. 6. 6⅝ AND 8⅝ INCH TUBES.

Chart showing Actual and Calculated Collapsing Pressures of Bessemer Steel Lap-welded Tubes Plotted to Thickness of Wall. Note that individual experiments are represented by crosses, calculated values by circles, and group averages by combined circles and crosses.

appearing as an angle or ell (L). Group averages are represented on these charts by means of combined crosses and circles.

It will be observed that the group averages of the actual collapsing pressures lie very close to the corresponding values calculated by means of formulas (*A*) and (*B*).

Formulas (*A*) and (*B*) being based upon the results of all the experiments on the 20-foot lengths of the lap-welded bessemer steel tubes tested, excepting the three that proved to be defective, it is clear that the curves plotted on these charts represent average values for the extreme range in thickness of wall for each of the seven diameters tested.

The scattering of individual results as compared with the general average appears, from these charts, to be restricted to comparatively small bounds when it is considered that we are dealing here with a product that varies noticeably in a number of the characteristics that go to make up its strength. Since these charts represent the results of tests on the common run of commercial lap-welded bessemer steel tubes, taken at random from the stock, it is surprising that the scattering of individual results is not greater than that shown.

The apparent fiber stress under which the different tubes failed varied from about 7000 pounds for the relatively thinnest to 35,000 pounds per square inch for the relatively thickest walls. Since the average yield point of the material was 37,000 and the tensile strength 58,000 pounds per square inch, it would appear that the strength of a tube subjected to a fluid collapsing pressure is not dependent alone upon either the elastic limit or ultimate strength of the material constituting it.

RELATION OF POINT OF COLLAPSE TO LENGTH OF TUBE.

Theoretically a tube should begin to collapse at the middle of its length, that is, at a point half way between transverse joints, or end connections, tending to hold it to a circular form. This statement is, of course, based upon the assumption that the material of the tube is perfectly homogeneous in its physical properties and that the diameter and thickness of wall are strictly constant throughout its entire length.

The truth of the above statement becomes apparent when we consider that the strength of a tube to resist collapsing pressure depends upon, first, the transverse rigidity of its wall and, second, the tendency of the end connections to hold the tube to a circular form. Since the former, for the assumptions made, would be constant from end to end of the tube and since the latter tendency would become less as the distance from an end connection increases, it is evident that a theoretically perfect tube subjected to a fluid-collapsing pressure would be weakest at a point that is at the greatest possible distance from both of its ends, which point is, of course, located at the middle of its length.

In commercial tubes, however, the material is not strictly homogeneous in its physical properties, and there is also a slight variation in out-of-roundness of the different cross-sections, from end to end, as well as a perceptible variation in thickness of wall. Because of these a commercial tube is not necessarily weakest against collaping pressure at the middle point of its length, as is the case for the theoretically perfect tube.

The actual relation of the point of collapse to the length of tube, for the several hundred commercial tubes tested, is shown on Fig. 7. This chart represents a 20-foot tube divided into foot lengths and numbered consecutively, beginning at the left-hand end. Over each division is placed the log number of the experimental tubes that collapsed at points nearest to that division. Thus, experimental tubes Nos. 100, 433 and 505 collapsed nearest the 9-foot division from the left-hand end of tube, while Nos. 422 and 452 collapsed nearest the 12-foot division.

It will be observed that the greater number of the tubes collapsed at points that are at distances of 2 feet and 18 feet from the left-hand end, that is, at a distance of 2 feet from each end, while comparatively few collapsed at or near the middle of their lengths. In fact, this chart shows that more than seven times as many of the experimental tubes collapsed at 2 feet from either end than at a point midway between the ends.

In order to have this chart show the relation of the point of collapse to the nearest end of the tube, it is obvious that we should transfer the test numbers of the right-hand half to the corresponding columns of the left-hand half; for example, we should transfer the test numbers over division 18, which is 2 feet from the right-hand end, to the column over division 2.

This has been done for all the columns of the right-hand half of the chart, the dashes shown being made to represent the test numbers of the right-hand half of the scale transferred to the corresponding columns of the left-hand half.

Since these experimental tubes were obtained by sending in orders in the usual commercial way, presumably they were taken at random from the company's stock, and, having been handled several times before being placed in the test cylinder, it is obvious that, since it is not known in which direction any of the tubes were passed through the mill while being manufactured, no significance can be attached to the fact that a greater number of the tubes failed nearer the left than the right-hand end. This chart, however, shows very clearly that the bulk of tubes placed under test were least capable of resisting fluid-collapsing pressure at a point near one end.

The reason why the bulk of these tubes collapsed near one end is evidently due chiefly to the following two facts, namely: (1) that a tube subjected to collapsing pressure is weakest at the point where the departure from roundness is greatest, even when this is small, and (2) that the greatest departure from roundness for the bulk of these tubes was near one end, as shown in Fig. 8.

CHART SHOWING RELATION OF GREATEST DEPARTURE FROM ROUNDNESS TO LENGTH OF TUBE.

Fig. 8 shows at a glance how the place of greatest departure from roundness is related to length of tube. For an explanation of the manner of construction see the description of Fig. 7, the two having been constructed according to the same general plan, the only difference being that Fig. 7 shows the location along the length of the tube of the point of collapse, while Fig. 8 shows similarly the location of the point of greatest departure from roundness.

These two charts, taken in connection with Fig. 9, show that the element of greatest weakness in a commercial lap-welded tube is its departure from roundness, even when this departure from roundness is comparatively small, as was the case with the tubes tested. Comparing these three charts with Fig. 10, it will be seen that the thinnest portion of wall, while in itself an element of weakness, is wholly subordinate to out-of-roundness in its influence upon the collapsing strength of commercial lap-welded tubes.

RELATION OF AXIS OF COLLAPSE TO SMALLEST DIAMETER OF TUBE.

The autographic calipering diagrams taken from the tubes before being placed in the hydraulic test apparatus show, as was to be expected, that none of the tubes tested were exactly round. This departure from roundness, while measurable by the refined methods used for its determination, was, nevertheless, small, varying all the way from zero to as much as possibly 2 per cent. of the diameter. It is apparent that, for homogeneous material and uniform thickness of wall, a tube whose cross-section is not circular will start to yield in the direction of its smallest diameter, and the axis of collapse will be coincident with the original smallest diameter at the place of collapse.

That the slight out-of-roundness of the tubes tested was the chief factor in determining the place of collapse is quite apparent from an inspection of Fig. 9.

This chart shows, for each tube whose test number appears, to the nearest 5 degrees, the angular distance from the axis of collapse to the nearest end of the original smallest diameter of the cross-section through the place of collapse. Since no significance need be attached to the plus

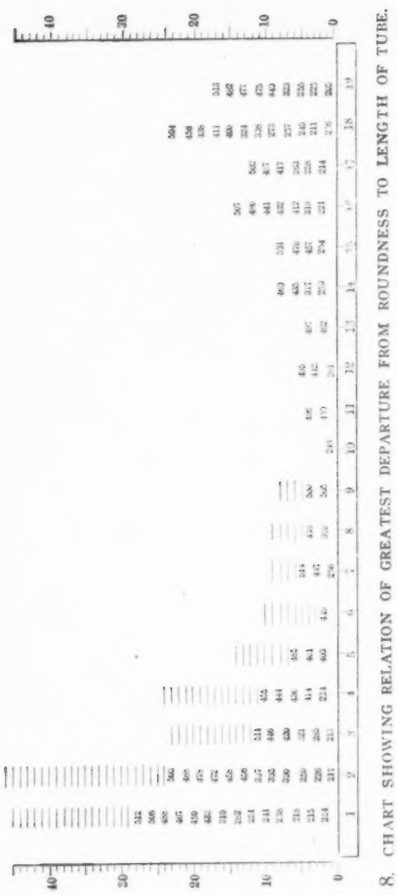


FIG. 8. CHART SHOWING RELATION OF GREATEST DEPARTURE FROM ROUNDNESS TO LENGTH OF TUBE.

FIG. 7. CHART SHOWING RELATION OF PLACE OF COLLAPSE TO LENGTH OF TUBE.

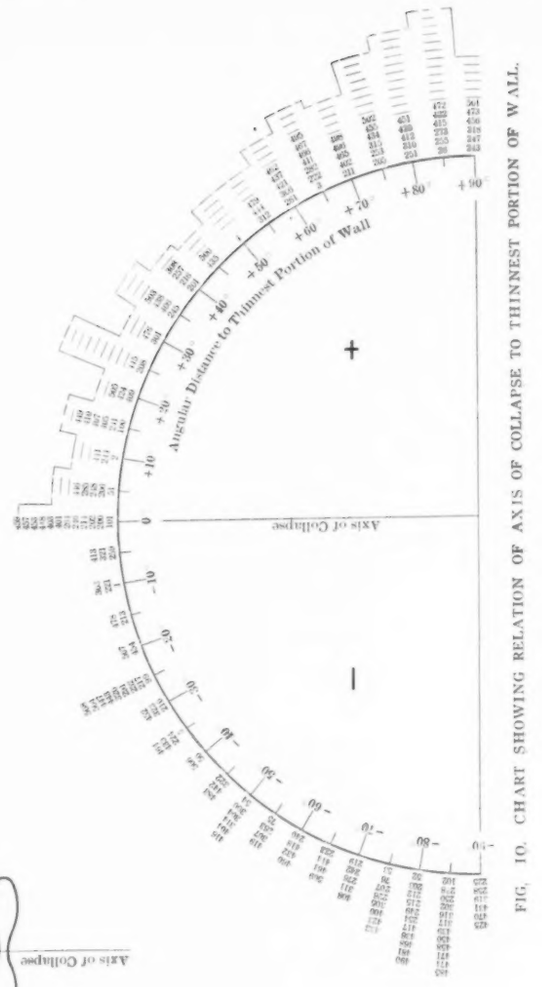


FIG. 10. CHART SHOWING RELATION OF AXIS OF COLLAPSE TO THINNEST PORTION OF WALL.

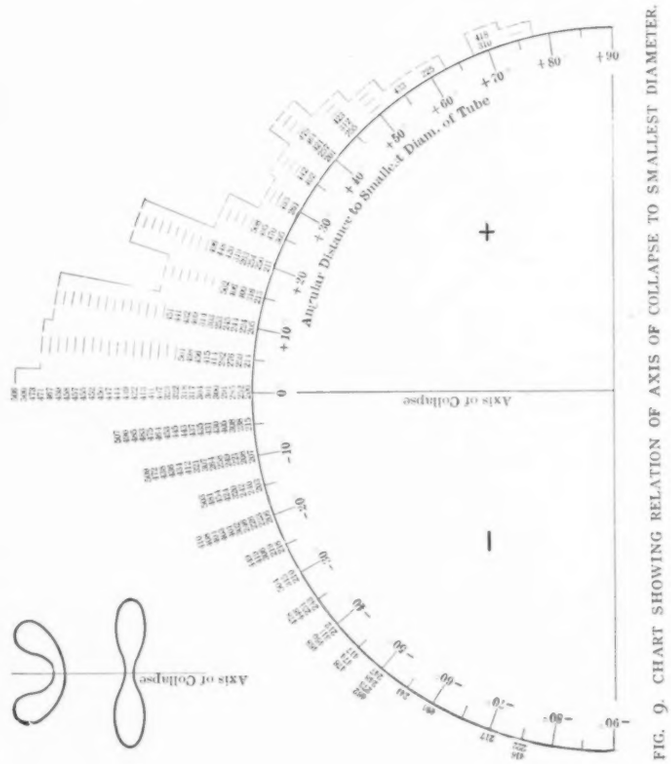


FIG. 9. CHART SHOWING RELATION OF AXIS OF COLLAPSE TO SMALLEST DIAMETER.

and minus signs on this chart, seeing that had any tube been placed in a reversed position in the test apparatus it would have also had the sign of its angular distance from the axis of collapse reversed, the test numbers having negative angles have been transferred to the corresponding columns containing those having positive angles. In order to avoid confusion the places of the test numbers thus transferred are indicated by dashes.

RELATION OF AXIS OF COLLAPSE TO THE WELD.

A chart similar to Fig. 9, but showing the relation of the axis of collapse to the weld shows that the angular distance from the weld to the axis of collapse, for the different test numbers, is quite uniformly distributed over about two-thirds of the possible distribution and shows conclusively that the weld, in itself, is not an element of weakness for tubes that are subjected to external fluid pressure.

RELATION OF AXIS OF COLLAPSE TO THE THINNEST PORTION OF WALL.

Fig. 10 is constructed on the same general plan as Fig. 9 and shows a fairly uniform distribution of the test numbers over about three-fourths of the possible distribution on either side of the axis of collapse, with a somewhat prominent increase over the remaining fourth.

A study of this chart in connection with Fig. 9 will lead to the conclusion that the tendency of commercial tubes is so to fail as to have the axis of collapse at right angles to the diameter through the thinnest portion of the tube. It should be observed in this connection that the bending action on the wall of a tube while being collapsed is most pronounced at this same point, that is to say, at 90 degrees from the axis of collapse. It will also appear, from these same charts, that for commercial lap-welded tubes the usual departure from roundness has a more pronounced effect in determining the manner of collapse. In other words, when these two influences are related so as to oppose each other the latter almost invariably predominates.

FACTORS OF SAFETY.

The formulas were derived from results of tests on 20-foot lengths of bessemer steel lap-welded tubes. They are, however, substantially correct for any length greater than about six diameters of tube between transverse joints or end connections tending to hold the tube to a circular form.

From an inspection of the charts it would appear that:

1. For the most favorable practical conditions, namely, when the tube is subjected only to stress due to fluid pressure and only the most trivial loss could result from its failure, a factor of safety of three would appear sufficient.

2. When only a moderate amount of loss could result from failure use a factor of four.

3. When considerable damage to property and loss of life might result from a failure of the tube, then use a factor of safety of six.

4. When the conditions of service are such as to cause the tube to become less capable of resisting collapsing pressure, such as the thinning of wall due to corrosion, the weakening of the material due to over-heating, the creating of internal stress in the wall of the tube due to unequal heating, vibration, etc., the above factors of safety should be increased in proportion to the severity of these actions.

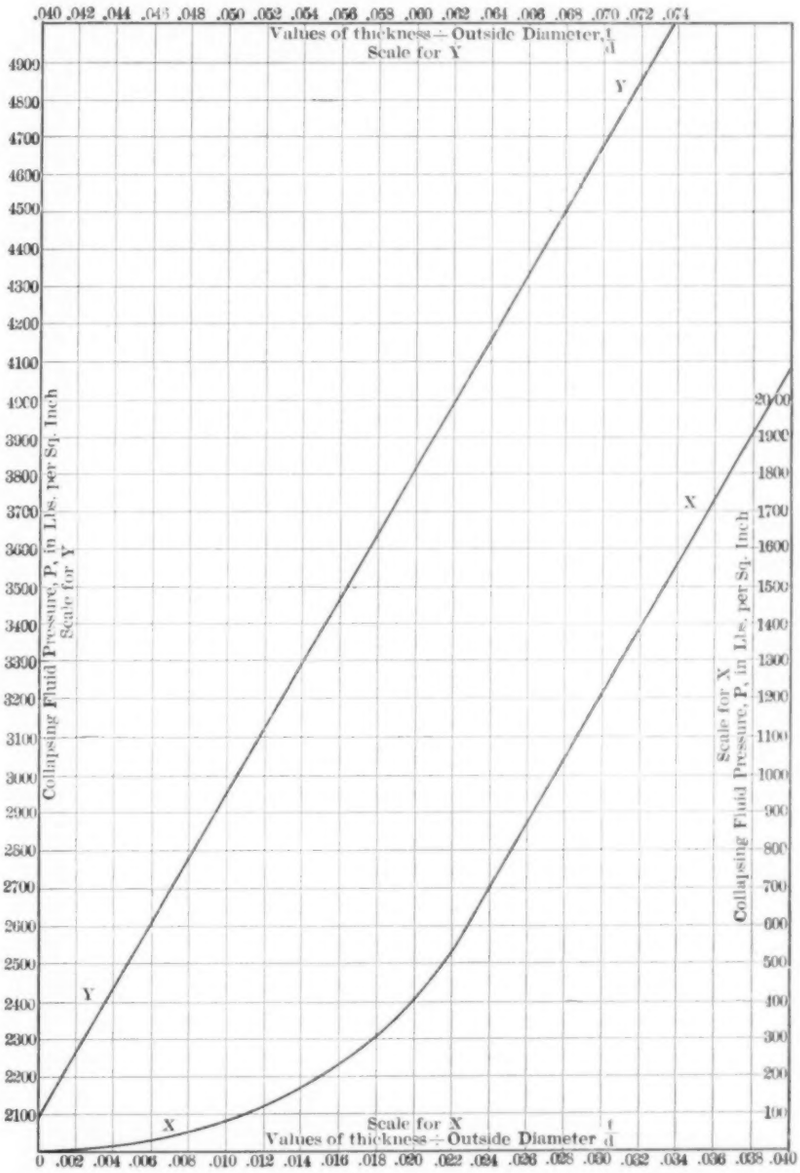

.040 .042 .044 .046 .048 .050 .052 .054 .056 .058 .060 .062 .064 .066 .068 .070 .072 .074
Values of thickness — Outside Diameter, t/d
Scale for Y
Y
Collapsing Fluid Pressure, P, in Lbs. per Sq. Inch
Scale for Y
Scale for X
Collapsing Fluid Pressure, P, in Lbs. per Sq. Inch
X
Scale for X
Values of thickness — Outside Diameter t/d
0 .002 .004 .006 .008 .010 .012 .014 .016 .018 .020 .022 .024 .026 .028 .030 .032 .034 .036 .038 .040

FIG. 11. CHART SHOWING PROBABLE COLLAPSING PRESSURES FOR LENGTHS GREATER THAN 6 DIAMETERS OF NATIONAL TUBE CO.'S BESSEMER STEEL LAP-WELDED CASING, PLOTTED TO THICKNESS OF WALL.

CHART SHOWING RELATION OF COLLAPSING PRESSURE TO $\frac{t}{d}$.

Fig. 11 resulted from plotting equations (A) and (B) to a vertical scale of probable collapsing pressures and a horizontal scale representing the thickness of the tube divided by its outside diameter, or the $\frac{t}{d}$ contained in these formulas.

By plotting in this manner, a single line may be made to represent the collapsing pressures of a great variety of tubes, irrespective of their individual diameters or thicknesses of wall.

In order to condense the size of this chart the curve is broken into two parts XX by YY. By this means the area of the chart has been reduced to about one-fourth of that which would otherwise have been required to construct the chart to the scales shown. It will be observed that YY is the upper portion of XX transferred to the left and then dropped down, the break in the curve corresponding to a collapsing pressure of 2080 pounds

and a thickness divided by diameter of 0.040. It will also be observed that the scales for the portion *XX* are at the lower and right-hand margins, while those for the portion *YY* are at the upper and left-hand margins.

The smallest divisions on the vertical scale represent 10 pounds collapsing pressure, while those on the horizontal scale represent 0.0002 thickness divided by outside diameter. When reading to the nearest smallest division on these scales the error will not exceed five pounds for probable collapsing pressure, nor 0.0001 for thickness divided by outside diameter.

This, then, is a universal chart showing the relation of the probable collapsing pressure of a tube to the thickness of wall divided by outside diameter. It represents the adjusted values of the group averages of all the 20-foot lengths of the bessemer steel lap-welded tubes tested, omitting the three that proved to be defective, and may therefore be used with entire confidence within the range of these experiments; that is, for bessemer steel lap-welded tubes from 2 to 12 inches outside diameter, and for all commercial thickness of wall in lengths greater than about six diameters of tube between joints or end connections tending to hold them to a circular form.

Example 1. Find by means of Fig. 11, the probable collapsing pressure of a tube having an external diameter equal to 6 inches, and a thickness of wall equal to 0.203 inch.

Dividing the outside diameter by the thickness of wall we get $\frac{t}{d}$ equal 0.0338. Since this value is less than 0.04 we look for it on the scale at the lower margin of the chart. Having found it on this scale, look along the vertical line through it until the line *XX* is reached; then look along the nearest horizontal line toward the right and read from the scale of probable collapsing pressures 1540 pounds per square inch. This is the probable collapsing pressure for a length of 20 feet, but is also substantially correct for any length greater than about six diameters, or 3 feet for a 6-inch tube, between transverse joints tending to hold the tube to a circular form.

Linear units for d and t—It should be noted that both the outside diameter, *d*, and the thickness of wall, *t*, must be expressed in the same linear unit of measure, as, for example, in inches, centimeters, millimeters, etc. The name of the linear unit is immaterial, the chart being just as applicable to obtaining probable collapsing pressures in pounds per square inch when the diameter and thickness are expressed in metric as when in English units.

Collapsing Pressures in Metric Measure—First divide the thickness of wall, *t*, by the outside diameter, *d*, both being expressed in either inches or millimeters. Second, obtain from Fig. 11, as in example 1, the probable collapsing pressure in pounds per square inch. Third, reduce the resulting collapsing pressure in pounds per square inch to that expressed in kilograms per square centimeter by multiplying by the conversion factor 0.0703.

Example 2. Find the probable collapsing pressure of a tube whose outside diameter and thickness of wall are respectively 15 centimeters and 4 millimeters.

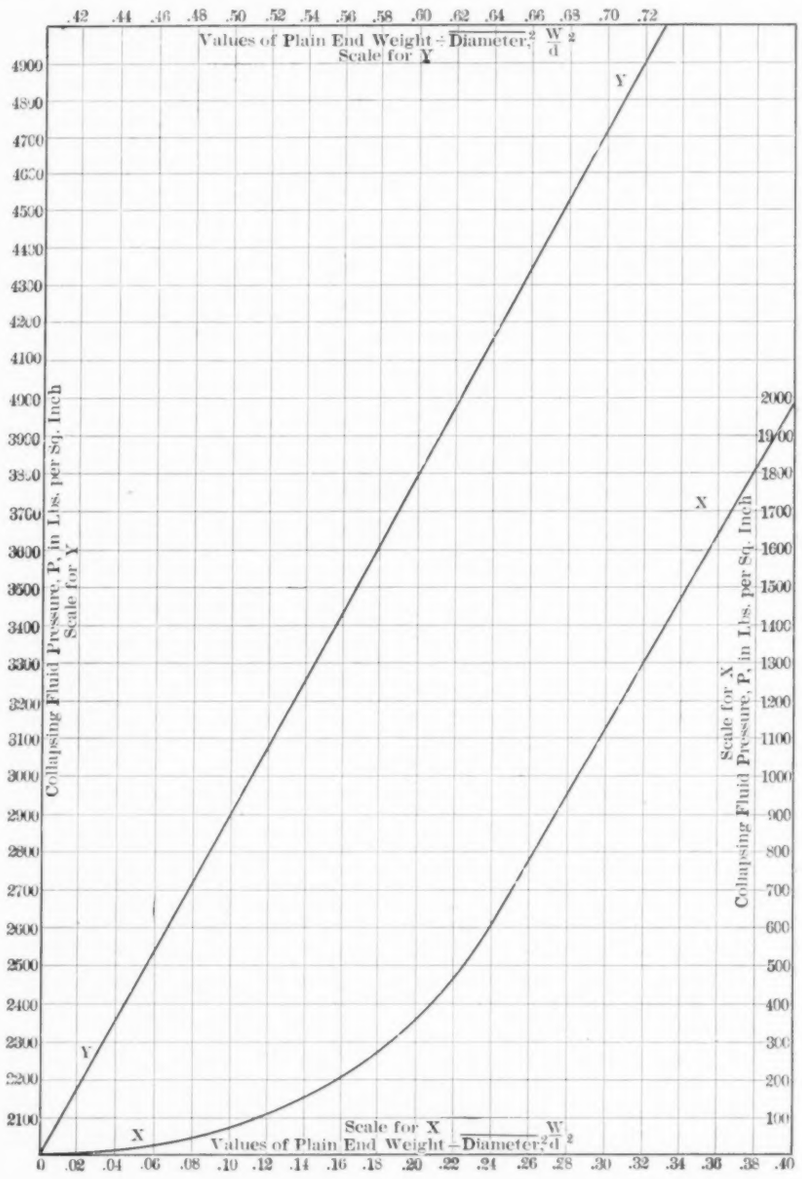

Values of Plain End Weight ÷ Diameter,² W/d ²
Scale for Y
Collapsing Fluid Pressure, P, in Lbs. per Sq. Inch
Scale for Y
Scale for X
Collapsing Fluid Pressure, P, in Lbs. per Sq. Inch
Scale for X
Values of Plain End Weight ÷ Diameter,² W/d ²
Y
X

FIG. 12. CHART FOR OBTAINING PROBABLE COLLAPSING PRESSURES FROM VALUES OF THICKNESS DIVIDED BY DIAMETER FOR LENGTHS GREATER THAN 6 DIAMETERS FOR NATIONAL TUBE CO.'S BESSEMER STEEL LAP-WELDED TUBES.

Fifteen centimeters being equal to 150 millimeters, $\frac{t}{d}$, or thickness divided by outside diameter, equals 0.0266. Proceeding as in example 1, we find the probable collapsing pressure to be 920 pounds per square inch. Multiplying this by the conversion factor for reducing English to metric units, given above, we get 920 multiplied by 0.0703, or 64.7 kilograms per square centimeter.

Example 3. With a factor of safety of 6 find what thickness a 3-inch boiler tube should have in order to resist a working external fluid pressure of 220 pounds per square inch.

In accordance with these assumptions, the probable collapsing pressure of the tube should equal the working pressure multiplied by the factor of safety, or 1320 pounds per square inch. From Fig. 11 find 1320 on the scale of probable collapsing pressures at the right-hand margin, and look along the horizontal line through this point until line *XX* is reached; then look down the nearest vertical line and read 0.0312 as the value of $\frac{t}{d}$ or thickness

divided by outside diameter. We can now get the required thickness of wall by multiplying the value of $\frac{t}{d}$ by d, which gives us t equal 0.0312×3, or 0.094 inch.

For the same conditions of pressure, a tube 8 centimeters, or 80 millimeters, diameter should have a thickness of wall equal 0.0312×80, or 2.5 millimeters.

CHART SHOWING RELATION OF COLLAPSING PRESSURE TO $\frac{w}{d^2}$.

Fig. 12 resulted from plotting equations (C) and (D) to a vertical scale of probable collapsing pressures and a horizontal scale representing the plain-end weight per foot divided by the square of the outside diameter, or the $\frac{w}{d^2}$ contained in the formulas. The errors of reading this chart should not exceed 5 pounds for the probable collapsing pressure, nor 0.001 for the weight divided by the square of the outside diameter.

This chart is based upon precisely the same experimental data as Fig. 11, the difference being that for any given size of tube this chart shows the relation of the probable collapsing pressure to the plain-end weight, while the preceding chart shows its relation to the thickness of wall. This chart should be used in calculations relating to collapsing pressure when the plain-end weight is either given or required, while the preceding chart should be used when the thickness of wall is given or required.

Example 4. Find the probable collapsing pressure of a 6⅝ (7 O. D.) inch casing whose plain-end weight is 17 pounds per foot.

Dividing the plain-end weight in pounds per foot by the square of the outside diameter in inches we get $\frac{w}{d^2}$ equal 0.347. Finding this value on the scale at the lower margin of Fig. 12 we look vertically until the line $X\,X$ is reached, then look horizontally toward the right and read 1525 pounds per square inch as the probable collapsing pressure required.

While this value is for a 20-foot length of tube, as in the preceding chart, it may be used without substantial error for any length greater than about six diameters, or in this case 3½ feet, between joints tending to hold the tube to a circular form.

Example 5. Find the plain-end weight per foot of a 5⅝-inch casing (6-inch O. D.) to withstand a maximum difference between external and internal-fluid pressures corresponding to a water head of 1200 feet, on the basis of a factor of safety of three.

A table of hydrostatic pressures will show that this head of 1200 feet will create a fluid pressure of 520 pounds per square inch, tending to collapse the casing at its lower end. Multiplying this by the factor of safety we get 1560 pounds per square inch as the probable collapsing pressure. Finding this value on the right-hand margin of Fig. 12, we look horizontally toward the left until line $X\,X$ is reached, then down the nearest vertical line and read 0.351 as the value of $\frac{w}{d^2}$, or plain-end weight divided by the square of the outside diameter. Now since $\frac{w}{d^2}$ equals 0.351, w will equal 0.351 multiplied by the square of the outside diameter, or $0.351 \times 36 = 12.6$ pounds per foot as the required plain-end weight.

Relative Corrosion of Wrought Iron and Steel.

In our report of the meeting of the American Society for Testing Materials, we referred to a paper by Henry M. Howe, Professor of Metallurgy, Columbia College, New York, on the above named subject. The following is the paper in full:

On one hand we have the very general opinion that steel corrodes not only faster but very much faster than wrought iron, an opinion held so widely and so strongly that it cannot be ignored. Smoke does not prove that fire exists; but such strong smoke bids us look carefully for fire. On the other hand we have the results of direct experiments by a great many observers, in different countries and under widely differing conditions; and these results certainly tend to show that this popular belief is completely wrong, and that on the whole there is no very great difference between the corrosion of steel and wrought iron. Under certain sets of conditions steel seems to rust a little faster than wrought iron, and under others wrought iron seems to rust a little faster than steel. Thus taking the tests in unconfined sea water as a whole wrought iron does constantly a little better than steel; and its advantage seems to be still greater in the case of boiling sea water. In the few tests in alkaline water wrought iron seems to have the advantage over steel, whereas in acidulated water steel seems to rust more slowly than wrought iron.

We, as technical and scientific men, naturally attach greater weight to the numerical results of careful direct comparative tests than to rumor and popular belief. When ultra conservative engineers used to cry out against steel boilers, it seemed to us like the old cry "Great is Diana of the Ephesians." Those who raised the cry, cried what they firmly believed was true, and what they thought every sensible man knew to be true. But they were wrong; and I need not tell this society that such cries and popular beliefs, even when widely and firmly held, often prove wrong. Compared with the results of direct comparative tests such beliefs have the great disadvantage of lacking all precise and definite foundation; they are easily spread from man to man. The fact that steel has come into wide use simultaneously with a great increase in the sulphurous acid in our city air and of strong electric currents in our city ground, may well lead the practical man, to be hasty or cautious, into inferring that the rapid corrosion of today is certainly due to the new material of today, steel, whereas in fact it may be wholly due to the new conditions of today, sulphurous acid and electrolysis. At the same time, while popular belief has the disadvantage of lacking direct numerical comparative data, it has the very great advantage of being based on the actual conditions of use, more closely, and often far more closely, than our direct comparative tests are, unless these are planned with very great care.

In view of this great discrepancy between popular belief and the results of our direct tests, it behooves us who have relied chiefly on these latter to examine their conditions carefully, to see whether they really have represented fairly the conditions of actual industrial use and service, in such a way that there is a real difference between the corrosion of steel and that of wrought iron, such a difference as would become manifest. In short, have our direct comparative tests been trustworthy?

Now, when I review our conditions in the light of this apparent contradiction between popular belief and the results of the differences between steel and wrought iron which ought to cause a difference in their rapidity of rusting, there are three prominent differences: (1) Blowholes; (2) Manganese; and (3) The presence of cementite in the steel and of cinder in the wrought iron. Let us take up these in order and see how they require that direct tests should be very prolonged or pushed to destruction.

(1) Blowholes exist in steel but not in wrought iron. But blowholes, at least blowholes which do not weld up and thus cease to exist, are not necessary. Yet they are to be prevented only by care and skill. Hence, get your steel only from careful and trustworthy makers.

(2) Steel always and almost necessarily contains more manganese that wrought iron. This may or may not hasten its rusting. If it does, then its effects ought to be made manifest even in short-time tests. From the fact that such tests do not show that steel rusts materially faster than wrought iron, I infer that this manganese is probably not a serious cause of rusting.

(3) Steel is generally richer than wrought iron in cementite, the iron carbide Fe_3C. Wrought iron always contains very much more cinder than steel. Each of these substances, the cementite of the steel and the cinder of the wrought iron, may have a double influence on corrosion, hastening it through difference of potential and retarding it by acting as a mechanical barrier like so

much paint, to exclude the oxygen or the air or the water. It is not clear that the influence of difference of potential ought to change materially as corrosion proceeds; but it is clear that mechanical protection given by the plates of cementite and of cinder ought to increase as corrosion proceeds. When a piece of wrought iron, for instance, is first exposed to corrosion, only the outcrops, so to speak, of the sheets of cinder come to the surface; its mechanical protection is very small. But as corrosion proceeds, and more and more of the metal which at first overlays the sheets of cinder is eaten away, the remaining cinder forms a larger and larger proportion of the outer surface, and therefore protects a constantly increasing proportion of the underlying metal from corrosion. In short, the mechanical protection afforded by the cinder ought to increase as corrosion proceeds. Here, then, is a cause which, as corrosion proceeds, should continuously tend to retard the corrosion of wrought iron, and to make it compare more and more favorably with steel. But, in like manner, as steel is gradually corroded away, more and more of its surface should come to be composed of cementite, and this fact should tend to retard corrosion of steel, because cementite, too, should protect the underlying free iron or ferrite.

These causes may, in time, reverse the initial relative rapidity of rusting of steel and wrought iron. Steel which in the first few months may rust faster than wrought iron may, on greatly prolonging the experiments, or pushing them to destruction, actually rust more slowly, and *vice versa*.

Now of the two, the cinder of wrought iron ought to gain more than the cementite of the steel, in its value as a mechanical retarder of corrosion, as time goes on and more and more of the metal is eaten away. The reason for this is that the cementite is in such extremely minute microscopic plates that the eating away of a very small quantity of the iron from above them ought to bring very nearly the full proportion of this cementite to the surface; whereas the much larger and more distantly scattered plates of cinder in wrought iron would not constitute their full share of the surface until a much thicker layer of initially overlying metal had been eaten away. This, then, may be the true explanation: that is, the reason why steel does not rust faster than wrought iron in our direct tests, though it does in actual use, is that our direct tests are too short to bring out the full protective action of the cinder of the wrought iron. Or the reverse may be true. As time goes on, the harmful effect of the difference of potential of the cinder may grow more than its protective action. Let us, therefore, henceforth push our tests to destruction.

Two other points: Sheet-steel roofing may rust faster than iron because it holds the paint better, and yet steel in other forms, like tubing, may rust no faster than wrought iron. Again let me emphasize the difference between different steels. Carelessly made steel, containing blowholes, may rust faster than wrought iron, yet carefully made steel, free from blowholes, may rust more slowly. Recognize that any difference between the two may be due not to the inherent and intrinsic nature of the material, but to defects to which it is subject if carelessly made. Care in manufacture and special steps to lessen the tendency to rust, might well make steel less corrodible than wrought iron, even if steel carelessly made should really prove more corrodible than wrought iron.

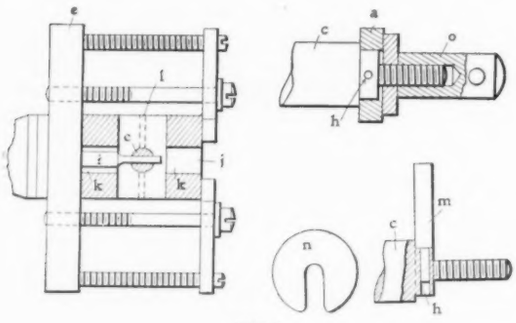


FIG. 1

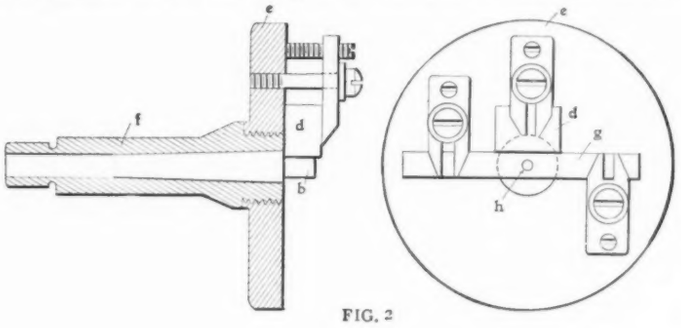


FIG. 2

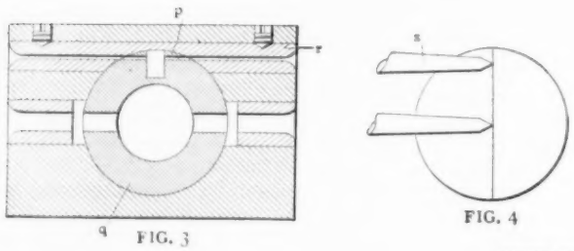


FIG. 3

FIG. 4

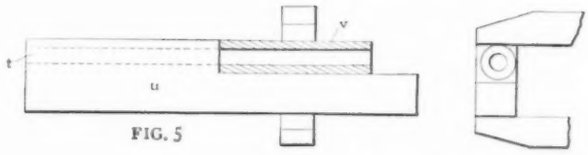


FIG. 5

Shop Tools and Methods.

BY F. J. LECARD.

In this article I show some actual practice in jig work.

First it is required to drill opposite holes in the ring shown in section at *a* Fig. 1, the holes to be in the center of the width of the ring. I generally carry for bench lathe work, brass pieces like *b*, Fig. 2, these having a taper shank and an end left projecting the full size of the rod, that is, ½ inch, ¾ inch and so on. It was required to have the holes correctly located, so that the work would be reversible. Piece *a* is to be held while drilling the holes on the arbor or stud *c*, shown also to smaller scale in the jig to the left, where it is pinned in position. The portion of plug *b* seen projecting in Fig. 2 is turned to the diameter of the body of *c*, which is held in the jig. A square piece *d* is clamped to *b* (though the clamps are not shown) and then clamped to the face-plate *e* of the lathe. The face-plate is then unscrewed from *f* and the plug *b* removed from the latter. Then the face-plate is returned and a rod *g* is clamped to it, this rod being located against block *d*. After removing *d* with its clamps, the face-plate is left well balanced for drilling and boring true a hole *h* in *g*, which is intended for the arbor *c*, Fig. 1, there being surplus stock on *g*, to be cut off as required in making *c*.

For occasional use as in this and similar cases, brass answers all purposes for plug *d* and is worked with facility.

Now the jig in Fig. 1 is ready to be clamped to the face plate. The stud *c* is left loose in the jig, and by using a pin *i* (held in a brass blank like *b*, Fig. 2 and turned true) the piece *c*, and the jig *j* are located, the hole *h* in *c* fitting on the

end of pin *i*. When in place, *c* is held by a set-screw (not shown) until doweled. The holes *k* for the bushings were located and drilled approximately before putting the jig on the face-plate. The whole thing having been removed for putting in the dowel pin *l*, is now returned, pinned to the face plate and clamped as shown. Then the face plate is taken off again with the work on, and the locating pin *i* is removed. The whole is then returned and the holes for the bushings bored out with the slide rest.

For locating the shoulder on the arbor *c* use a pin *m*, the diameter equaling the width of *a* and the small part fitting the hole *h*. Face off the shoulder until the large part of the pin passes the shoulder with the small part in the hole.

The collar *n* with the open slot is to permit the removal of ring *a* from the arbor without taking off the nut *o*.

Fig. 3 is a similar jig to the other but having a small hinge-pin hole at *p*. In this case I was furnished with a model, and having set the work *q* in the jig, I located the holes as before, afterward setting and clamping to the face-plate, removing the locating pin and the model from the jig, and then replacing and boring out the holes for bushings. The long bushing *r* (really two bushings) was put in place and secured with two set-screws and bored out before being hardened to fit the surface of *q*. This allowed the small drill to be guided readily on the curved surface of the piece. The hole in the bushing was drilled first and the outside then turned.

If I had been required to make a model, I should have located the small hole in the jig by using an indicator as at *s*, Fig. 4, the model being milled off one half at the end, and the indicator point extended through the roughly located bushing hole, the latter then being bored true.

Fig. 5 shows how a long hole in an irregular shaped piece was drilled on centers. A round brass guide, made from a rod was soldered to the work and the center *t* found with the surface gage. The stock *u* and guide *v* were each ¼ inch and being laid on a surface plate and clamped were soldered together for drilling the hole in *u*. Had the hole in *v* not come true when made in the bench-lathe chuck, then a larger rod could have been turned down after making the hole, to insure accuracy. The method followed, however, gave the best of results.

A leading article in the current issue of *Moody's Magazine* discusses the fall in the value of bonds, which has been going on for some time, and attributes it to the increased production of gold, which it is asserted has, on account of this increased production, fallen in purchasing power in the ratio of about 1 to 1.47; that is to say, according to Dun's index number, $1.47 will buy what $1 would have bought about 9 years ago.

Ball-Bearing Design.

BY P. S. BUSHNELL.

Ball-bearing practice has in the last two years centered about the two-point type as being the best adapted to withstand hard usage and carry the necessary load, both the annular ring, and the race and cone designs receiving their share of attention. The formulas and table herewith will be found useful for designing the latter type of bearing. Only two pressure angles are here considered, 30 degrees being used where the load acts in a direction perpendicular to the center line of the journal, and 45 degrees when considerable thrust as well as the perpendicular load must be taken care of.

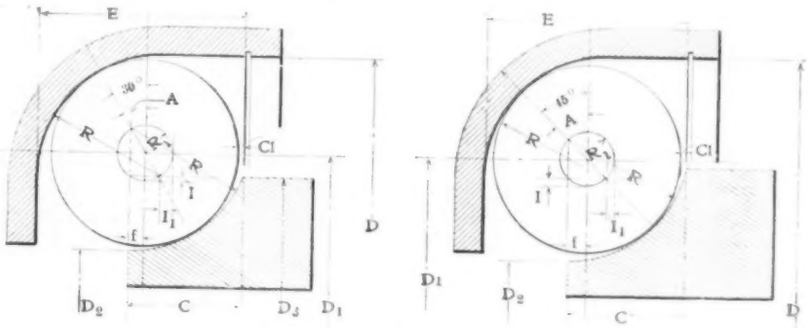


FIG. 1. BALL BEARING DESIGN.

I and I_1 may be found for any angle by the formula:

$I = R_1 - (R_1 \times \text{cosine of angle})$.

$I_1 = R_1 - (R_1 \times \text{sine of angle})$.

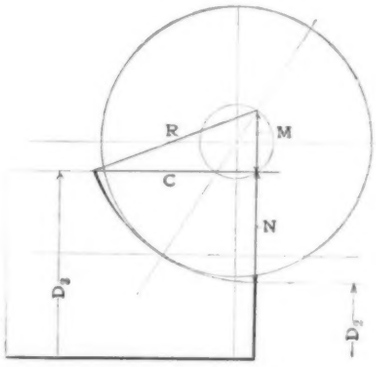


FIG. 2. DERIVATION OF FORMULA FOR C.

For 30- and 45-degree cones these formulas become:

30° *cone* $\begin{cases} I = R_1 - (R_1 \times .866) \\ I_1 = R_1 - (R_1 \times .5) \end{cases}$

45° *cone* $\begin{cases} I = R_1 - (R_1 \times .707) \\ I_1 = R_1 - (R_1 \times .707) \end{cases}$

2 I for a 1" ball $\begin{cases} 30° = .04 \text{ inch.} \\ 45° = .088 \text{ inch.} \end{cases}$

2 I for any diameter of ball using 30- and 45-degree pressure angles may be found by the following proportions based on *2 I* for a 1-inch ball.

For 30 degrees:

$$.04 : 1 :: x : d.$$

For 45 degrees:

$$.088 : 1 :: x : d,$$

d being the diameter of the ball.

Formulas for *R* R_1 and the other dimensions are as follows in which

d = diameter of ball.

N = number of balls.

l = clearance between balls.

$$R = \frac{d}{2} \times 1.3 \qquad R_1 = R - \frac{d}{2}$$

$$D = \frac{d + l}{\sin. \frac{180}{N}} + d + 2\,l$$

$$D_2 = D_1 - (d + 2\,l)$$

$$f = R_1 \sin. A$$

$$C = \sqrt{R^2 - \left[R - \left(\frac{D_3 - D_2}{2} \right) \right]^2}$$

$$E = d + I_1 + Cl$$

Referring to Fig. 2 the derivation of the formula for *C* is as follows:

$$C = \sqrt{R^2 - M^2}$$

in which

$$M = R - N$$

and

$$N = \frac{D_3 - D_2}{2}$$

giving

$$C = \sqrt{R^2 - \left[R - \left(\frac{D_3 - D_2}{2} \right) \right]^2}$$

D_3 and *C* are important dimensions of the cone as the proper adjustment of the bearing depends upon their correctness.

The table gives values for many of the dimensions for *N* from 9 to 25 and for *d* from ¼ to 1⅜ inch.

N	$\sin \frac{180°}{N}$	*d*	For 30°			For 45°	
			I_1	*I*	*2 I*	*I* and I_1	*2 I*
9	.64202	.25	.0.8	.005	.010	.011	.022
10	.80902	.312	.0233	0063	.012	.0137	.0274
11	.28173	.375	.0281	.0075	.015	.0165	.033
12	.25882	.4375	.0328	.0088	.017	.0192	.0384
13	.23931	.5	.0374	.010	.02	.022	.044
14	.22252	.562	.042	.0113	.4226	.0247	.0494
15	.20791	.625	.0467	.0126	.025	.0275	.055
16	.1951	.687	.0518	.0138	.027	.032	.064
17	.1838	.750	.0562	.015	.030	.033	.066
18	.1737	.8125	.0608	.0163	.0326	.0357	.0714
19	.16434	.875	.0655	.0175	.035	.0385	.077
20	.15643	.937	.0702	.0187	.036	.0412	.0824
21	.14904	1.	.075	.02	.04	.044	.088
22	.14234	1.062	.079	.0206	.041	.0467	.0934
23	.13616	1.125	.084	.0225	.045	.0495	.099
24	.13053	1.25	.094	.025	.05	.055	.11
25	.12533	1.375	.103	.0275	.055	.065	.13

DIMENSIONS OF BALL BEARINGS.

The Problem of Smoke Abatement.*

BY WILLIAM H. BRYAN.

Attempts at smoke abatement are almost as old as the art of burning fuel itself. The subject is almost as attractive to the average inventor as is perpetual motion. To the engineer who works in this field will come many experiences, some pleasant and some unpleasant, but all interesting.

First of all, there is the cheerful crank, whose furnace consumes everything by passing the gaseous products of combustion back underneath the grates. Devices without number of this character have been seriously proposed. It is needless to say, however, that none have been successful. Even those which have been tolerated temporarily have found it necessary to discharge some gases and admit some fresh air.

Then there is the man who sprinkles the smoke with a jet of water—in other words, laundries it. Another school mixes with the smoke so large a surplus of air or steam, or both combined, as to practically drown the smoke out, or dilute it to harmless proportions. The effect on the coal bill can be imagined. Other inventors have processes by which they extract from the waste gases by-products of fabulous value.

The trouble is that few inventors realize the complications and difficulties of the problem. The average steam boiler is subject to wide variations in its output, and is often overworked. More often the setting is in bad repair, and was of poor design originally, in grate surface, gas area, and flue and chimney dimensions. Oftener still, the poorest grade of unskilled labor is employed. When, in addition, such a furnace is required to handle the poorest grades of fuel, it is hopeless to attempt to control the smoke.

Not every man, however, is willing to do his share toward reducing the smoke cloud. First, and most important, is often the manufacturer himself. His argument is that a smoky city is a busy city, and that restricting smoke means interference with his business affairs, restricting and hampering his output. He tells us that a smoky, but busy city is preferable to a dead town with a clear atmosphere. His argument falls to the ground when we remember that a smokeless chimney is not inconsistent with severe and continuous boiler service.

Other objectors are those who have made attempts—more or less earnest and intelligent—to stop the smoke, but have failed. In most cases the attempt has been only half hearted, but in others much money has been spent in misdirected effort. Many such people believe that the smoke cannot be stopped, and that it is useless to try.

*Lecture delivered before the students of Purdue University.

What is smoke, anyway, and what causes it?

The constituents of all fuels may be classified as volatile matter, fixed carbon and ash. The ash is inert as regards smoke except that when present in large quantities, it impedes the proper handling of the fires, necessitating frequent cleaning, which is always detrimental. The fixed carbon, with which we are familiar in the form of coke, is smokeless. The remaining constituents, the volatile matter, occurs in large percentages in our western fuels, and to it the smoke is due.

When a fuel rich in volatile matter is charged into a furnace, the volatile matter is first set free as a gas, principally in the shape of hydro-carbons. Part of these are of the olefiant series, and are dissociated at a red heat. Part of the carbon is set free, and, if, unconsumed, it passes off as smoke. It is possible to burn this free carbon, if sufficient oxygen is present, and the temperature is high. Failing in either of these conditions there will be smoke.

The free carbon in the densest smoke is very small, from one-sixth to one-half of 1 per cent. by weight. It has, however, great coloring power. You may stamp as false all claims of fuel saving due to consuming the smoke. The best furnaces, however, do make savings in fuel, not because they burn the smoke, but because improved construction and better engineering details bring about more favorable furnace conditions. The saving is often more than sufficient to pay a good interest on their cost, besides repairs and maintenance.

Broadly speaking, there are three methods of reducing smoke; First, the closing down of smoke-making plants; second, the use of smokeless fuels; third, the burning of ordinary fuels smokelessly.

Heroic as it may seem, much good has been accomplished by the actual shutting down of plants. A few years ago all large cities were dotted with small factories, each with its smoke-making boiler. Today such plants are operated by electric motors, supplied with power from central stations located at a distance and provided with smoke-preventing apparatus. Many buildings get their entire service of light and power from the street mains, operating their boilers only during the cold months for heating. This practice may be expected to grow as electricity becomes cheaper, and is distributed over wider areas.

Much has been done in smokeless fuels, particularly for heating in the residence districts, and for many special operations. It is not too much to ask of the average good citizen that he will, if necessary, go to some expense to aid in beautifying his city. This, however, could not be expected under steam boilers, which are the largest smoke producers. It was hoped that oil from the Texas fields could be introduced at something like reasonable cost, but present rates are prohibitive. Oil has many advantages, however, which would justify a considerable increase in cost over coal. In addition to solving the smoke problem it greatly reduces the labor charge, can be handled and controlled more easily and usually permits an increase in the working capacity of the plant. On the other hand, however, the elements of danger and of odor are ever present. As indicating in a general way what may be done under boilers with the various fuels coming to the St. Louis market I prepared a table some time ago, based on St. Louis prices ruling before the recent advances. No claim is made for the absolute accuracy of the figures,

Fuel.	Cost Dollars.	Calorific Value Heat Units	Efficiency, Per cent.	Equivalent Evaporation in lb. of Water.	Cost of Evaporating 100 lb. of Water.
	Per 1000 Cubic ft.	Per 1000 Cubic ft.		Per 1000 Cubic ft.	Cents.
Fuel Gas	0.10	240,000	80	198.8	50.30
	Per Ton of 2000 lb.	Per lb.		Per lb.	
Anthracite	6.75	14,000	75	10.87	31.08
Texas Oil	8.08	15,950	80	13.22	30.56
Coke	4.50	12,500	70	9.05	24.87
Pocahontas	4.75	13,300	72	9.90	24.00
Big Muddy	2.50	12,200	68	8.57	14.60
Mt. Olive, lump	1.60	11,200	65	7.53	10.62
Powdered Coal	1.25	10,000	80	8.28	7.55
Common Slack	0.90	10,000	60	6.20	7.25

but they are believed to be fairly reliable—relatively, at least. A glance is sufficient to show that the smokeless fuels are out of reach in cost, except possibly as the use of powdered coal may be developed.

The deliveries in this table are assumed to be on cars at consumer's switch. The oil weighs 7.43 pounds per gallon, and at the same time cost 3 cents per gallon, 2½ cents of which was freight. This price has since been raised, but even at these figures it falls short of competing with coal, even after adding 40 to 50 cents per ton for handling the coal and ashes. The outlook for oil would be better if, instead of burning it under boilers it be used in oil engines of the Diesel or other modern type, which consume about ¾ pound of oil per i.h.p. hour. The ordinary Corliss engine uses about 4 pounds of Mount Olive coal per i.h.p. hour. At these figures the fuel cost would be practically the same for oil as for coal.

In the table above it is assumed that the powdered coal is made from ordinary slack, at an additional cost of 35 cents per ton for powdering. This charge will be offset by the saving in labor for coal and ash handling.

After all, however, our greatest hope for relief lies in burning ordinary fuels smokelessly. As the worst offenders are

the steam boilers, they only will be discussed. Devices without number have been invented for this purpose, but, unfortunately, most of them have failed to meet the exacting requirements of regular service.

It should be remembered that a good ordinary boiler furnace without a special device, can be so handled as to greatly reduce the smoke, providing, of course, it is not overworked. It is not necessary, therefore, to buy somebody's patent furnace. Nor will the installation of improved apparatus of itself control the smoke. A deep furnace, high bridge wall, ample grate surface and good draft are essential to a good smoke record. Such a furnace, skilfully fired, will make no serious smoke when working up to, say, two-thirds of its rated capacity. By skilful firing is meant the charging of alternate doors with small and uniform quantities of fuel, particularly if the coking system of firing is used. The firing of consecutive doors, at long intervals, with large quantities of fuel, and by the sprinkling method, is responsible for a very large proportion of our smoke.

If the furnace, however, is not well designed, or is overworked, no amount of skill or care will keep the smoke within bounds. In such cases resort must be had to special apparatus. Successful processes may be divided into five classes:

First, Steam Jets. These are the simplest devices in use, and can be put together by any engineer at small expense. Sometimes they are placed under the grates, discharging into the ash pit, but more often they are above the grate, immediately over the fire doors or in the side walls, discharging backward or across and slightly downward. The jet draws in air and discharges it at high velocity immediately above the fire, where it meets the gases being given off by the disintegrating fuel.

Devices of this character have come into extensive use. They are reasonably effective in reducing smoke, but are not usually economical in fuel. The jets are often allowed to blow continuously, but it is better to turn them on at the time of firing and then shut them off in two or three minutes, after the fresh fuel has been ignited. In some devices this is done automatically, the act of opening the fire door turning on the jet admitting steam and air, and clockwork or dash-pot mechanism gradually closing it.

Second, Coking Furnaces or Firebrick Arches. These come next in first cost, and are capable of giving almost perfect results in smoke abatement if properly designed and intelligently operated. The fire-box is kept well away from the cooling effect of the heating surface, and can therefore be maintained at high temperature. Contracted checker work, or throat areas, insure a thorough mixture of air, which is often preheated. These are built in many forms, many of which are capable of burning very inferior fuels. They are excellently adapted to plants where the service is reasonably uniform. The objections are that some forms require an increase of space, and the brickwork, if not properly constructed may not be durable and repairs may be large. These objections, however, have been very largely remedied in the best types. There will usually be a material saving of fuel over the common setting if properly constructed and operated.

Third, Down-Draft Furnaces. These have proved very successful in many instances, and have come into extensive use, particularly where excessive demands for overwork are frequently made.

In the Hawley, one of the best known forms, there are two grates, one above the other. The upper grate is a row of water tubes, single or staggered, so connected as to form part of the circulation system of the boiler. Grates of the ordinary pattern would not withstand the high temperatures. The tubes are inclined upward to the rear to insure rapid circulation. The space above the rear drum is closed off, and the gases must make their exit downward through the bed of fuel. Considerable partly burned fuel falls to the lower grate, where its combustion is completed under very favorable conditions. The two flames unite at the rear of the grates, forming a throat through which it is almost impossible for the particles of free carbon to pass unconsumed. Somewhat greater draft is usually required for this furnace than for the common setting. Most of the air required for combustion enters through the doors above the upper grate, a small amount being admitted under the lower grate. The furnace is independent of the skill or ignorance of the fireman to greater degree than many others. The objections are its first cost, and the fact that it is part of the present system of the boiler. With bad water or careless or insufficient handling, there is great liability to tube and drum repairs. It usually effects a considerable saving in fuel.

Fourth, Automatic Stokers, with which may be classed chain grates and underfeed devices. These have come into extensive use, particularly in large modern plants. While they are built in many forms, they all operate on the same principle—that of feeding the coal automatically to the grates in continuous and regular amounts. Most of them are designed for the use of the finer grades of coal, such as nut, pea or slack. In many localities there is a surplus of this fuel, and its cost is low, but the increasing demand is raising the price and reducing the supply. Many recent stoker plants are provided with crushers to permit the use of the larger sizes of coal when necessary. When accompanied by coal handling and storage plants, the automatic stoker reduces the labor required in the fireroom, and this arrangement has been adopted in many large modern plants. The ability of the stoker to maintain practically uniform steam pressure, and the fact that the air supply is nearer theoretical requirements, are features which have contributed largely to its success.

The objections to automatic stokers are: First, their great cost; second, the complication of parts and the necessity of repairs; third, the steam required to operate them. Under proper conditions there is a material saving both in fuel and labor. That the objections named are not serious is shown by the fact that their use is constantly increasing. The fuel to be burned should have expert study, however, before a device of this kind is selected, as they are not equally well adapted to all fuels. Some do not respond to fluctuating loads, and to overwork, as well as other types of furnaces.

Fifth, Powdered Fuels. These have recently attracted much attention, having for years been employed successfully in rotary cement kilns, and more recently under boilers to a limited extent. Experiments along this line have been under way for some time in European countries with considerable success. In the most satisfactory devices the coal is reduced to an almost impalpable powder, and is then forced into the furnace under pressure, exactly as would be done with oil or gas. Among the greatest advantages of this fuel is the fact that it may be made of slack or mine waste, which can be had at very low cost. While the apparatus for burning fuel is simple and inexpensive, the plant necessary for preparing the fuel is somewhat elaborate. As the fuel is explosive and liable to spontaneous combustion, it cannot be stored or handled in quantities, but should be used as fast as made. This would seem to call for a powdering plant at each point of use. There is reason for hoping, nevertheless, that good results may be looked for in the not distant future.

Space will not permit a discussion of all the methods which have been proposed, but the foregoing covers in a general way the devices which have been more or less successful. The list would not be complete, however, without mentioning double combustion furnaces, and mechanical draft, which has come into limited use with encouraging results, both alone and in combination with others of the above named types.

The classifications enumerated above are not always clear and distinct, as the types named are often found in combination. The fire-brick arch, for instance, is nearly always found in combination with the stoker, and often with the steam jet.

The fireboxes of locomotives and of steamboats require special treatment, but brick arches and steam and air jets have given good results. The best work is done when the two are combined. Some experiments have also been made with down-draft furnaces, with promise of success. Oil is admirably adapted for locomotives

and is already in extensive use where the cost will permit. It is urgently recommended that large grate and heating surface be provided wherever possible.

I am unhesitatingly of the opinion that at least one—usually more—of these devices is applicable successfully to every smoke-making boiler, and that, too, without hardship. Great care, however, must be exercised; first, in selecting the apparatus, to insure that it is properly adapted to the service, second, in seeing that it is carefully applied, so as to be reliable and durable, and, third, that it is intelligently operated and maintained. The last is perhaps the most important of the three. No apparatus, however efficient, can be expected to run itself. Give it a chance; see that it is taken care of and kept in repair, and not abused.

Incidentally the smoke-abatement movement has led to a closer study of boiler conditions, with the result that the modern boiler room, in arrangement, lighting, ventilation, and general efficiency, is a creditable piece of engineering. It is entitled to be given at least as much attention, both by the designing and the operating engineer, as any other part of the plant. Hardly less important is the proper care and management of the boilers, and particularly of the fire itself. A good fireman should be encouraged. It pays to keep a good man, even at an advance in salary, for his hand is in the owner's pocket all the time.

The following directions regarding intelligent methods of firing with a view of securing efficient and smokeless performance may be of interest:

Fire frequently and in small quantities. Break up the lumps to the size of a man's fist. Carry a level fire over the entire grate surface, not too thick. Avoid thin or bare spots. Keep the fires clean.

Fire one door at a time, and wait until that fire is in good shape before charging the other door. Keep the time intervals between firings as nearly uniform as possible.

Fire not over three shovelfuls per door to begin with. If this makes no serious smoke, increase to four shovelfuls, and then to five or six shovelfuls until the smoke from the chimney shows that the limit has been reached.

Immediately after each firing leave the fire door slightly ajar for three or four minutes, thus admitting a little fresh air above the bed of fuel.

Our sympathy goes out to that individual who complained in a newspaper recently that the soot from the smoke so soiled the snow that he could not play snowball, as in childhood's happy days. Nor can we answer that individual who expects the smoke department to do away with our river fogs. More interesting but even less tractable, is our friend who, when the banquet is over and cigars lighted, dares us to do our worst in preventing smoke.

Seriously, however, it is not a losing fight. Most cities now have strict ordinances controlling the smoke question, and more or less effort is being made toward their enforcement. As a rule, the courts are sustaining these laws. Some eastern cities, among them New York and Washington, prohibit the use of soft coal altogether, and I am informed that it is an offense in New York to even have it on the premises. More good, however, is done by moral suasion, than by legal procedure, appealing to the civic pride of the average good citizen, and pointing out that the best methods insure a fuel economy amply justifying the original outlay.

Mishaps and discouragements are not unknown in the work, but the appeal to good citizenship, the education of the public, and—more than all—keeping everlastingly at it, will surely bring relief to any smoke-encompassed town.

Humanity and Machinery.

Machinery is the cornerstone of modern society, the very foundation on which law, science, ethics, the arts, even the State itself rests. It is so new that we do not yet know its poetry. We do not yet understand. Only two generations have lived beside the highway of steam; only one has seen the bessemer converter transform the blacksmith into a master builder of ships and towers. The sewing machine, the far speaker, the typewriter are common things of today, accepted as a matter of daily convenience, and yet are they teachers of the people. Machines that come close to our lives and homes insensibly teach truth, precision, the adjustment of universal laws to human needs, respect for that wise American idea that labor saved is labor released for higher and nobler toil. The machine is the head master of the high school of the race—*Reader Magazine.*

The astronomers of Greenwich Observatory are much perturbed because the vibrations from the new electric powerhouse, half a mile away, built for the London County Council, shake their mercury mirrors and spoil their observations, while the hot gases from the chimneys disturb the atmosphere, and interfere with accurate astronomical observations. The station contains four 3500-kw. vertical-horizontal steam engine generating sets. One would think that this interference with the famous observatory on the precious meridian of Greenwich might have been foreseen and avoided before the commencement of the four-and-a-half million dollar power station.

Low brass is more likely to fire-crack than is high brass; the amount of it used is comparatively small and is confined to drawn or spun articles which cannot be successfully made from high brass.

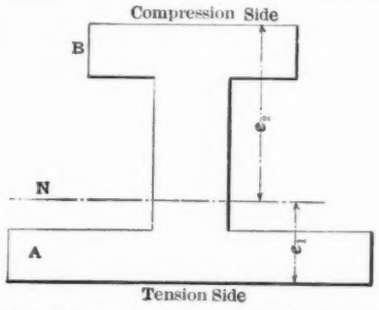
Letters to the Editor.

Cast-Iron Beams.

Mr. Osborne, in his facetious article on Cast Iron Beams at page 832, has given us a very realistic picture of the difficulties sometimes had in the drafting room with the application of formulas found in handbooks, etc. The impression to be gathered from this article, however, is that the writers on mechanics and strength of materials have neglected or left in an inconclusive condition the matter to which he refers. That this is rather unfair to the said writers may be proved by the following extracts from two authors which I happen to have at hand, and no doubt much more on this subject could be found if a search were made.

In Church's "Mechanics of Engineering," under the subject of "Safe Loads in Flexure," we find the following:

"In the case of cast iron, however, the elastic limit is reached in tension with a stress = 9000 pounds per square inch, and a relative extension of $\frac{66}{10000}$ of one per



CROSS-SECTION OF A CAST-IRON BEAM, HAVING GREATER AREA AND LESS STRESS AND STRAIN ON THE TENSION SIDE.

cent., while in compression the stress must be about double to reach the elastic limit, the relative change of form (strain) being also double. Hence with cast-iron beams, once largely used but now almost entirely displaced by rolled wrought-iron (steel) beams, an economy of material was effected by making the outer fiber on the compressed side twice as far from the neutral axis as that on the stretched side. Thus, in the figure, cross-sections with unequal flanges were used, so proportioned that the center of gravity was twice as near to the outer fiber in tension as to that in compression, i.e., $e_2 = 2e_1$; in other words, more material is placed in tension than in compression. The fiber A being in tension (within the elastic limit), that at B, since it is twice as far from the neutral axis and on the other side, is contracted twice as much as A is extended; i.e., is under a compressive strain double the tensile strain at A, but in accordance with the above figures its state of stress is proportionally as much within the elastic limit as that of A."

Church gives the maximum safe stress in the outer fiber for cast iron as 6000

pounds in tension and 12,000 pounds in compression.

In Reuleaux's "Constructor," page 8, we also find this matter discussed, under the title of "Value of the Quantity *S*." I notice that in this book the word *strain* is sometimes used in the sense of *stress*, an error often made in common speech but hardly to be expected in a scientific treatise; so in making the quotation I will change the text and replace *strain* by *stress*, where *stress* is evidently intended. The quantity *S* referred to means the unit stress in the beam.

"The limit of elasticity in a deflected beam, both on the tension and compression sides, will be reached when their respective stresses *S* become equal to the modulus of resistance."

By modulus of resistance is meant the elastic limits for tension or compression respectively.

"It is therefore of great importance to select such a value for *S*, that the modulus of resistance may not be reached on either side. These conditions will be met for sections which are symmetrical about two axes, by taking the lesser of the two values of *S*, as in the case of cast iron, the modulus for tension should be used.

"In those sections in which a' differs from a'', the first thing to be determined is the position of the tension and compression sides."

a' and a'' are the distances from the extreme fibers to the center of gravity or which is the same thing, to the neutral axis, in cases where the center of gravity is not in the middle of the depth of the beam.

"Let

- a = the greatest distance from the neutral axis on the tension side.
- a_1 = the greatest distance on the compression side.
- T = the modulus for tension,
- T_1 = the modulus for compression.
- M = the statical moment of the bending force.
- m = the coefficient of safety, so that for double, triple, safety, etc., $m = 2$, or 3.
- J = moment of inertia of the section with respect to the neutral axis.

"Then we may take:

When $\frac{a}{a_1} > \frac{T}{T_1}$ then $M = \frac{T}{m} \frac{J}{a}$

When $\frac{a}{a_1} < \frac{T}{T_1}$ then $M = \frac{T_1}{m} \frac{J}{a_1}$

When $\frac{a}{a_1} = \frac{T}{T_1}$ then $M = \frac{TJ}{ma}$ or $\frac{T_1}{m} \frac{J}{a_1}$

"Thus, for cast iron, $\frac{T}{T_1} = \frac{1}{2}$.

"With wrought iron, in which $T = T_1$ no investigation is necessary.

"SECTIONS OF UNIFORM RESISTANCE.

"In order to use the material to the greatest advantage to resist bending forces it is necessary to pay especial attention to its distribution, particularly in those portions which are furthest from the neutral axis. The best economy is attained in this matter when the section is shaped so that the stresses on both tension and compression sides shall reach the elastic limit simultaneously.

"For this purpose it is necessary to make

$$\frac{a}{a_1} = \frac{T}{T_1}$$

"Sections which are thus proportioned are known as Sections of Uniform Resistance. Wrought-iron sections which are symmetrical about two axes fulfil these conditions, since $T = T_1$. For cast iron, when the bending force is exerted constantly in one direction, it is best to make $a_1 = 2a$, for $T_1 = 2T$."

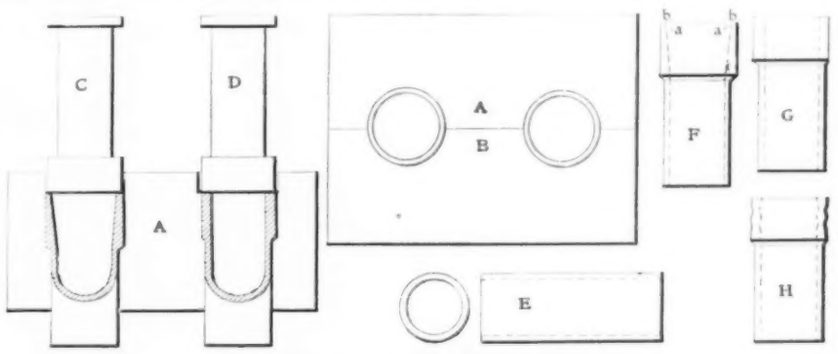
The subject of Sections of Uniform Resistance is then illustrated and discussed.

It would be interesting, if time permitted, to make a study into the cases instanced by Mr. Osborne, but I think the above quotations will be enough to show that the "authorities" have not neglected the matter. BRACHISTOCHRONE.

Upsetting the Ends of Boiler Tubes.

Having had some experience in upsetting boiler tubes, I was surprised to learn that some manufacturers of tubes cannot overcome the difficulty of upsetting boiler tubes without leaving grooves in or outside the collars, as shown at *H*. I am working where boiler tubes are used by the carload; having examined some of them, I found grooves in them.

One day we were in a hurry for 400 boiler tubes, and as it would require a few weeks to get them from the East, our superintendent ordered them to be made at home. It was the first time we had made any; and, though there was a foreman in charge who knew the way of upsetting boiler tubes in the East, considerable difficulty was experienced in making them, and we also could not prevent the grooves forming.



UPSETTING THE ENDS OF BOILER TUBES.

Having solved the problem of upsetting boiler tubes without leaving any marks or grooves, I send you this drawing and description. The illustration at *C* shows the new header with swell or taper neck; it is for the first operation and expands the tube as shown at *a*, Fig. *F*. The object of the expansion is to prevent grooves on the collars, as shown at *H*. *D* is the header for upsetting boiler tubes in the old way; it leaves grooves on the collars. This header can be used for the second operation, and leaves a perfectly smooth finish, as shown at *G*. *B* is the die with headers for both operations. *F* shows the collar after the first operation in the new way; *b* is the end of the collar—it is the same thickness the tube was before the first operation; *i* is the heavier part of the collar at the back. *G* is the finished collar after the second operation in the new way. *E* is the tube before the first operation. *H* is the collar showing the groove when made in the old way. *A* and *B* are the dies.

The advantage of the new taper header is not only the better and smoother finish, but also in the length of collar. With the old header (now used for the second operation) collars only up to three inches long could be made, while with the new or both headers collars of five inches or longer can be made.

On a bulldozer or bolt machine, where the two headers can be adjusted for use at the same time, collars can be finished with one welding heat for both operations, if not over three inches long.

California. A. Z.

Power Transmitted by Worm Gearing.

Referring to the worm-gear power diagram given by Mr. Raeburn at page 505, I would like to see some little explanation of it, showing what factors necessary to the satisfactory working of a gear on examples which have proved successful have been taken into account and allowed for, and which have to be allowed for by the user. Also, is it based entirely in practice, or has it some theoretical basis, and if so, what?

As I understand the diagram, it seems that for a certain horse-power and speed, the pitch which will be most satisfactory is given by the diagram, and fixing the diameter of the worm, limits the amount of work which will be lost in friction that the worm will stand without heating or cutting. Is this the only factor taken into account? A word or two on this subject

by one who has studied it would be appreciated by those who have to design worm gears.

There is also another question I should like to ask: Under what conditions would a gear as designed by his diagram, work satisfactorily? A. MONTAGUE.

An Internal Milling Fixture—Another Special Milling Device.

The internal milling fixture described at page 513 by S. Bliss brings to mind a milling fixture which we made in our shops for performing an awkward operation. While this fixture is in no way similar to the one referred to above I believe it to be so unlike the average milling tool that it merits attention and will be interesting to your readers who have similar problems to solve.

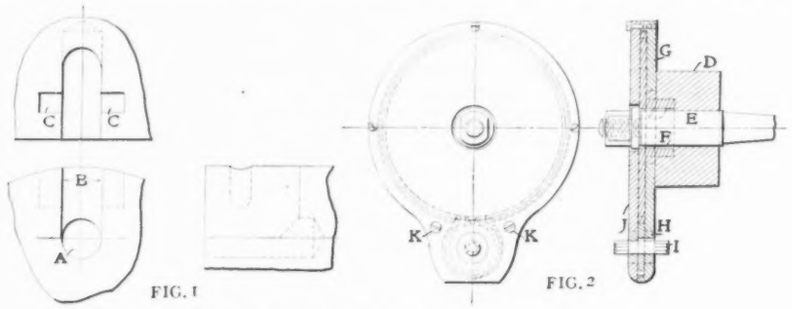


FIG. 1 FIG. 2

THE WORK AND THE MILLING DEVICE.

Fig. 1 shows the job to be machined by this fixture. The hole *A* admits a round sliding piece with rack teeth cut on its side for a portion of its length. Slot *B* is milled into hole *A* as shown and is for a gear which engages with the rack teeth mentioned. This gear is pivoted on a pinion which is seated in the grooves *C*. The hole *A* and slots *B* are easily machined but the operation of putting in the grooves *C*, and getting them an exact depth to allow the gear to mesh properly with the rack was not at first an easy proposition. After a number of pieces had been spoiled (and some were barely passable even when done by a thirty-cent man) the fixture in Fig. 2 was devised and, needless to say, it is in constant use and gives very accurate results. A ten-cent boy can now finish the job just as well as the experienced mechanic.

In Fig. 2 *D* is a circular block of a diameter to fit in the arm of the milling machine in which it is clamped in the usual manner, and is bored out to receive spindle *E* and gear *F*. The spindle is tapered as shown to fit the taper hole of the milling-machine spindle. The case *G* is bored out to clear *F* and the pinion *H* and is pressed on the block *D* as shown. Pinion *H* has hubs which come almost flush with the sides of the case in which it takes its bearing, the pinion proper taking care of the end thrust. Cutter *I* is keyed in pinion *H* and is of the proper length and diameter to mill correctly the grooves *C* in Fig. 1. The cover *J* closes the whole and is held in place with screws shown. The case with the cover in place is made of a width to make a neat sliding fit in the slot *B* in the work and is rounded at the bottom to fit the round of the hole *A*. The distance from the center of cutter *I* to the bottom of the round is the same as that from the center of grooves *C* to the lower side of the hole *A*. It is obvious that all that is necessary to complete the job is to sink in the fixture as far as it will go and the operation is finished. Care must be taken to have the fixture a neat fit in the slot so that no chips can fall under it and thus cause an error in the depth. It will also be seen that screws *K* must have heads flush with the case else they will interfere with the slot when entering.

L. F. B.

Holding the Edges of Thin Templets Together.

It is very annoying to hold the edges of templets together when they are but 1/16 inch thick; but still it is done by many good mechanics, who perhaps do not know of a better way.

If a piece of glass is held with one templet against it, the other can be tested to it readily by holding to the light.

WINAMAC.

An Experiment in Milling.

The object of this experiment was to determine whether there was any saving in milling two rows of castings, of the shape illustrated in Fig. 1, set side by side, over milling a single row.

The machine used was a No. 5 Cincinnati milling machine.

The arbor and cutters are illustrated in Fig. 2. In milling the two rows a second gang of cutters was used on a longer arbor, with a support between the two gangs, using, however, the same diameter of arbor. These cutters were made of high-speed steel, and in both cases the machine was pushed to its full capacity, consistent with obtaining work free from chatter. The size of the arbor was limited to two inches by the size of the tapered end, and the latter was once twisted off in the experiments with double rows.

From the experiment it was found that a cut of 0.247 inch per revolution of cutter was the most practical limit for milling the single row, this being equivalent to a table travel of about four inches per minute, for a total width of cut of about 8½ inches, and average depth of cut about 5/32 inch.

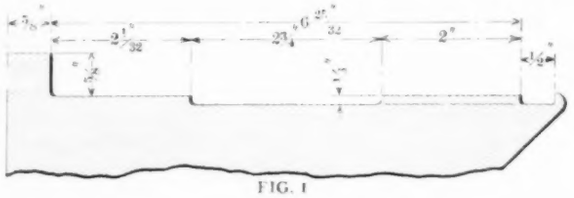


FIG. 1

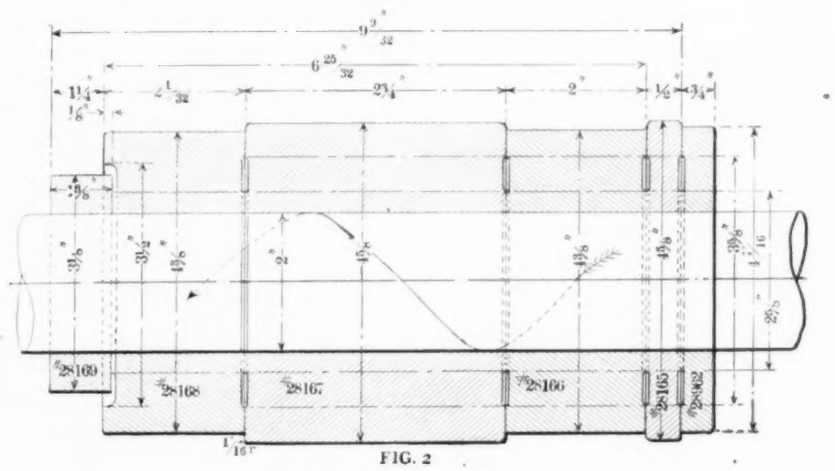


FIG. 2

AN EXPERIMENT IN MILLING.

For the double rows it was found that 0.098 inch was as fast a table travel as was practical with the same speed and feed of cutter, or about 1½ inches travel per minute; for a total width of cut of about 17 inches; and while the time consumed in setting up the two rows was a little less than twice that for setting up one row, this saving was so slight that it

did not at all offset the longer time for milling. In both cases we worked up to the pulling capacity of the belt, a four-inch double belt, and in fact were overloading it.

With the single row we were removing roughly 5.3 cubic inches of metal per minute; with the double rows only 4.2 cubic inches. FORD.

Pipe Hangers.

The common U-bolt, Fig. 1, forms about the simplest and cheapest pipe hanger when there exists a suitable structure overhead for attaching it. The rod should be threaded for a considerable distance on each end for adjustment, and for pipes subject to vibration such as steam, exhaust, hydraulic pressure lines etc., there should be jam nuts or other form of nut locks. Where the distance to the point of support is excessive, or the overhead structure favors attachment at a single point, Fig. 2 is suitable. If a flat bar is used for the crossbeam, it should be bent as shown in dotted lines.

Fig. 3 shows a complete hanger with clamp suitable for attachment to the lower flange of an I-beam. The strap in which the pipe rests is made from a broad flat bar of wrought iron or steel varying in thickness from ⅛ inch or even less for very small pipes, to ⅜ or 7/16 inch for large sizes. A turnbuckle with lock nuts provides a means for adjusting the length. The rod-ends in the turnbuckle are upset to give the same strength at the root of the thread as in the full section of the rod, and the whole forms a strong sightly hanger suitable for nearly any location where minimum cost is not considered a matter of first importance.

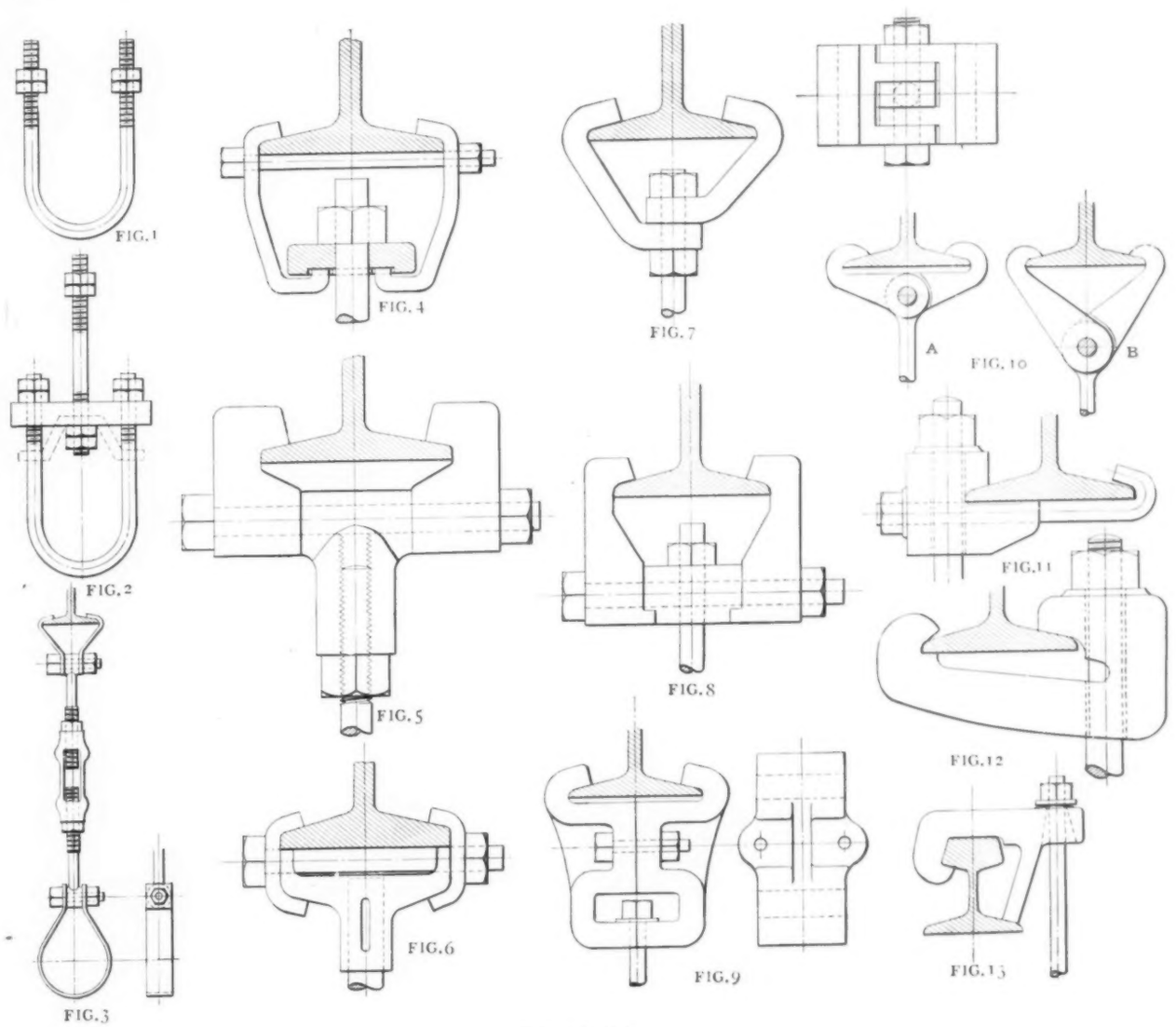
A large percentage of the pipes in use at the present time are suspended from overhead beams, and Figs. 4 to 12 show a variety of clamps intended for this purpose. These are mostly designed to be made of steel castings or forgings, or if of gray iron they should be exceptionally heavy in proportion to the loads they are required to support. On lines subject to shock, it is useless to attempt the determination of hanger dimensions by calculation of the dead weight to be carried. Only good judgment qualified by experience is of any use in this case, and about the only rule to be followed is the one which says "when in doubt make it stronger."

Fig. 10 is commonly made as shown at *A*. There is less stress upon both the pin and the clamps if made as shown at *B*.

Fig. 13 shows a hanger on T-rails used for supporting heavy pipes in a tunnel with smaller pipes hung beneath them.

Large vertical pipes are usually supported from the bottom by means of a properly constructed special fitting provided with a base for resting upon a masonry foundation. Smaller ones may be suspended from above by rods connecting to a split collar placed beneath a convenient pair of flanges. Sometimes a vertical line is supported about midway of its length by a fitting made of a bracket form and bolted to a wall or floor beam.

GERALD E. FLANAGAN.

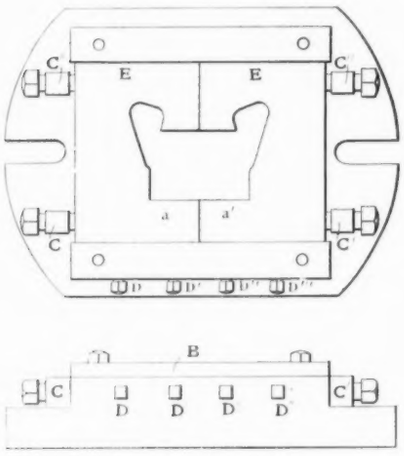


PIPE HANGERS.

Another Split Die.

The plan, with stripper removed, shows the sections *a a'* and the joint *C C' C'' C'''* are studs screwed into the bolster plate and carry set-screws.

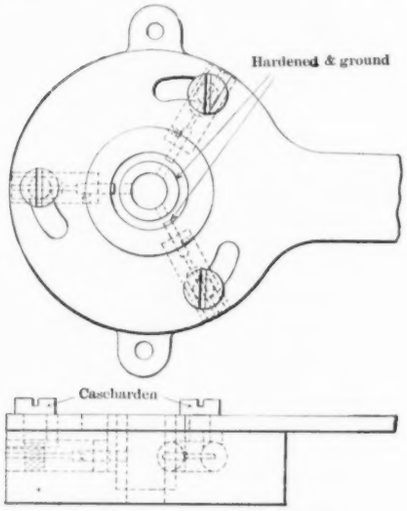
The screws *D D' D'' D'''* thrust the sections *a a'* into a slight taper in the back at *E*. The elevation shows the stripper *B* which helps to hold the die sections down. The joint was stoned to a perfect fit and held close by set-screws through the studs. This die has given entire satisfaction in every way and has cut thousands of blanks from 14-gage half-hard sheet brass. H. E. S.



ANOTHER SPLIT DIE.

A Multiple Hand Punch.

The sketch shows a hand punch for piercing three small holes at once in a thin brass shell. The plan gives a clear idea of the principle, which leaves little to explain. The cam plate is made of mild steel, the body of gray iron and the punch holders are of round cold-rolled stock. The bushing or die in the center is forced into the cast-iron body a short distance, and further secured with a set-screw (not shown, nor, for the sake of clearness, are the holding-down lugs shown on the elevation). The small holes going through the punch holders permit broken punches to be driven out. J. T.



THE MULTIPLE HAND PUNCH.

Some Knife-Edge Tools.

Fig. 1 shows a knife-edge bevel; at the top is shown the stock. It is one of the handiest tools for use on the surface grinder. It is made of tool steel, hardened and ground all over.

Fig. 2 shows knife-edge straight-edges *A* and *B*, a test bar *C*, a test block *D* and knife-edge square *E*. I have had considerable trouble in keeping them true, especially in winter. The warmth of the hand would throw them out of true. I overcame this by putting in the fiber or hard rubber as shown by the dotted lines. These tools should be kept in a box with a little oily waste to prevent rust.

CHAS. W. TUCKER.

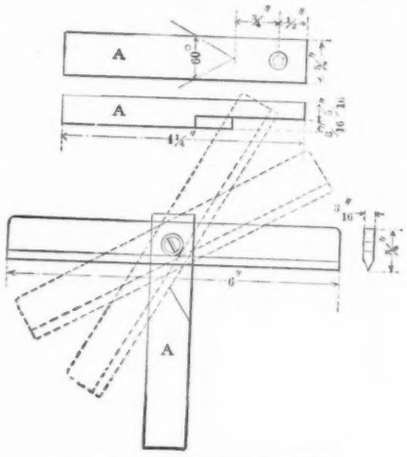


FIG. 1. A KNIFE-EDGE BEVEL.

Rapid Work on the Automatic.

The job was to drill a 7/16-inch hole 1⅝ inches deep in the center of a bar of ¾-inch round cold-rolled steel and cut the piece off 1⅝ inches long, slightly chamfering the corners. The automatic was set up in the ordinary way with a stop-centering-tool and drill in the turret, a cutting-off tool in one post and a chamfering tool in the other. With this arrangement we got out somewhat less than 200 pieces per day; the drill wouldn't stand up for any more. This seemed to worry the head of the firm a great deal. For some reason he was deeply interested in this job, so the operator and I put our heads together to see what improvements could be made. High-speed steel drills were the first thing suggested and these we tried with good results, but now an idea suggested itself by means of which we were able to turn out an unusually large amount of work. The job was on a Brown & Sharpe No. 2 automatic turret forming machine. These machines are so arranged that the turret can be revolved at any time regardless of the position of the cams and without interfering with their movement in any way. The movement consumes little time, so the idea was conceived of using two 7/16 drills, letting the first drill about 60 per cent. of the depth of the hole, then withdrawing this drill, revolving the turret and bringing a fresh cool drill into use. In this manner we got out considerably more work but we soon found that the second drill going into a deep hot hole where it got very little oil on its cutting edge soon heated up. So we decided to put in a third drill. This last one did not drill more than ¼ inch but it came out as hot as the first one.

Now the cutting-off tool would not stand up so we decided to make new cams for the turret and cutting-off tool and utilize every instant of the time with the cams. The cutting-off tools hardly got out of the way of the stock when the chuck opened and fed the bar forward and no sooner was the chuck closed than

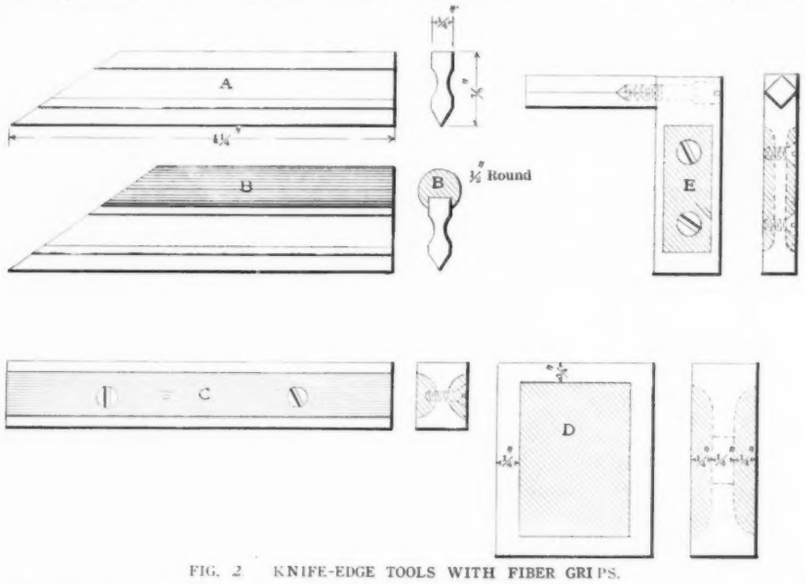


FIG. 2. KNIFE-EDGE TOOLS WITH FIBER GRIPS.

the cutting-off tool was at work and the turret revolving, bringing into position the centering tool. This tool was fed very slowly, using about 60 per cent. of the turret cam for 1/16-inch of throw or travel, but this allowed the first drill to get started before reaching the more adrupt part of the cam which had 1¾ inches throw. After the cutting-off tool had entered the stock about 1/16 inch the chamfering tool came up and did its work. By the time the last drill was withdrawn from the hole the piece was severed, but owing to the angle of the cutting edge of the parting tool there was a ring still left on the stock which must be removed. This was done rapidly, using only 5 per cent. of the cutting-off cam for the purpose, this last portion of the cam being very abrupt. After the machine was set up in the manner described it turned out an average of 56 of these pieces per hour, or about three times the amount turned out at the start, a result that was well worth working for.

R. Earl Weinland.

A Drawing Board for Patent Office Drawings.

Referring to the letters on this subject by B. R. Judd and Paul A. Kaeppel at pages 325 and 393 I wish to state that I have made and used a drawing board with plate glass surface, for tracing and printing purposes, introducing artificial or other light at the under side of the glass to assist in doing my work from pencil drawings, months before the article by Mr. Judd appeared, and I was intending taking out a patent myself, after making a few improvements.

My board is practically the same as the one he shows only a little larger in the plate glass and I place it upon four corner legs or feet, with a light underneath if necessary; therefore, I am safe in claiming the honor, if any, to the invention.

Wm. Heyes.

Castleford, Englannd.

Machining an Automobile Steering Gear Part.

Fig. 1 shows what we call a "ball end socket." It is made of gun bronze and is part of an automobile steering gear.

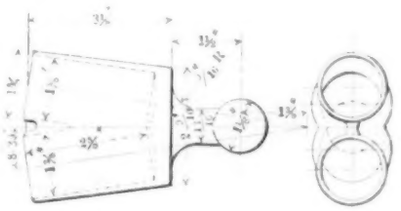


FIG. 1. THE WORK.

Fig. 2 is the main body of the fixture that was made for holding it while being machined in the turret lathe. It is virtually an angle plate. The hole *A* is threaded to fit the spindle of the turret lathe. The part *B* can be made as heavy as necessary to counterbalance *C* and the other parts attached to it. The part *E* we call the "cradle"; it is made to fit the casting Fig. 1. It is pivoted on the angle plate *C* at *D*. The angle plate *C* is fitted at *F* with a locating plug which fits in bushings at *G* in *E*. The casting of the ball end socket is secured in the cradle *E* by the clamp *H* held by studs at *I*. One member is machined, the locating plug *F* is withdrawn and the cradle *E* is swung to center the other member and locked in place by the locating plug.

Nomad.

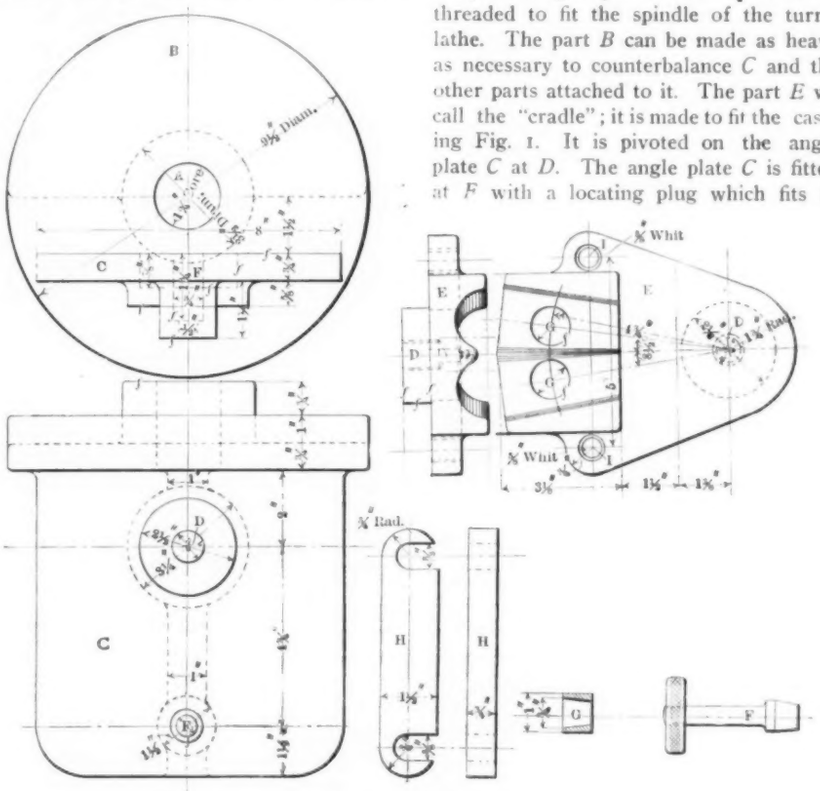


FIG. 2. THE FIXTURE.

Setting Automatics.

Having had something to do with the operation of automatic screw machines, I have been much interested in the article by Fritz Schkommodan at page 843 entitled "Setting Automatics." I believe it is a good idea to have some such system as he describes for changing machines from one job to another, but it is a question in my mind as to just how far such a system should be carried; for when we start in to note down working points or dimensions for adjusting turret and other tools to, there is really no very logical point at which to stop until the entire series of possible adjustments has been covered, and as a result of thus carrying out the idea consistently I am afraid so many figures would be put on file that the average screw-machine man would prefer to go at the job in the old-fashioned way of setting with sample, caliper and scale, making a few final adjustments by cut-and-try methods.

Without doubt where a job is coming up regularly every month or so, as so many do to be run perhaps for a week or ten days, some few data which may be easily obtained and filed, will be of considerable service to the man in charge of setting operations. On the Cleveland machine which is mentioned in the article referred to, the location of the cam strips on the slotted disk or drum which regulates the speed of the feed-drum drive and hence the feed of the turret tools, should be useful, as should also a note giving the positions of the main feed cams which operate the turret itself, and of the cross-slide control. It would seem, however, that the location of the forming tool on the cross-slide could be determined about as conveniently from the cutting-off tool itself, and by using a sample or a sketch of the work, it should be an easy matter to set the turret tools very closely to position at the first attempt; at least so far as their distance from the outer side of the cutting off tool, or the forming tool, is concerned. After all, the adjustments requiring the most time to make are those which bring the cutters in the box tools, etc., to the right position for shoulder lengths, diameters of bodies, and threaded portions, and such adjustments must necessarily be made finally on the cut-and-try basis. Oftentimes the setting of these tools will occupy more time than the adjustment of most of the other parts of the machine combined, yet it is obvious that one cannot very well place on record any figures by which the adjustable cutters, back rests, pointing tools, etc., may be set immediately to bring the work dead to size and length.

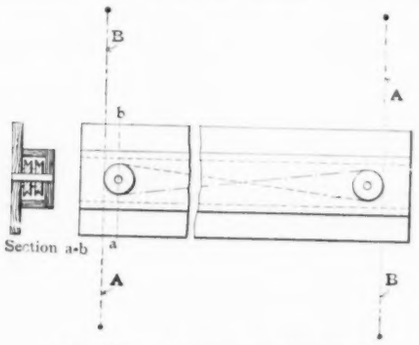
Unless a screw-machine department is confined to the manufacture of a very limited number of parts, the adjustments for which it may perhaps be possible to set down quite fully, it would seem best

merely to jot down some few general particulars and then only for the jobs which may be considered as regular items of manufacture. It is customary in some places to place on a card bearing a sketch of the piece a note giving the countershaft speed, or rather which step of the cones the belt is run on, the size of the overhead pulley which in the Hartford type of machine is sometimes changed to change the speed of the drum shaft, and to stamp the cams and note down their numbers, along with the numbers of the corresponding turret tools. Where change gears are used, as in the Brown & Sharpe automatic, it is well to give the number of the gears on the card with the sketch of the piece. The cards used should be shellacked on both sides, so that they may be handled without being soiled; they will prove much handier than any record book or sheet which contains the data for the whole department and to which no one with greasy hands can conveniently refer. Let the workman take the shellacked card to the machine and keep it there during the setting up operation.

F. A. STANLEY.

Parallel Motion Straight-Edge.

I observed a draftsman using a parallel motion straight-edge the other day which seemed different from those usually employed. It uses the principle of crossed cords as indicated in the sketch, but these cords are crossed in the device itself, and not behind the board as usual. The straight-edge is fitted with a box running its whole length and at each end of this box are mounted two loose wheels around which the cords are passed. These cords are fastened at each end. For example cord *A* is fastened to the upper right-hand corner of the board, passes down the



PARALLEL MOTION STRAIGHT-EDGE.

right side and around the upper wheel, thence through the box to the upper wheel at the left-hand end of the rule and from there down the left-hand side to the bottom edge of the board, where it is fastened.

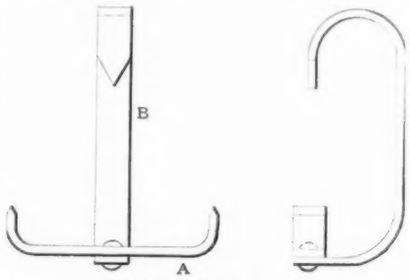
This makes a remarkably simple, inexpensive, and rigid affair. For long drawings, I do not think it could be excelled. It can be moved by gripping it anywhere along its length and will stay parallel.

F. W. HARRIS.

Piston-Rod Thread Gage.

The shop in which I am employed does a great deal of repairing on modern high-speed automatic cut-off steam engines in sizes up to 24-inch diameter of cylinders, and the screw gage or caliper shown in the sketch was devised to get us out of one of the difficulties incident to this particular branch of the repair business.

In a large proportion of engines of this



PISTON-ROD THREAD GAGE.

general character the piston rod is secured to the crosshead by a thread on the rod fitting into a tapped hole in the crosshead and with a lock nut behind the boss of the crosshead to make all rigid. This makes a good and secure fastening and usually proves satisfactory to everybody concerned, until in the course of time the repair man reaches it, when its possibilities for causing trouble are quickly shown.

In this sort of repair work new pistons and piston rods are very often the main part of the job; and when you get an order for a new piston and rod, you don't get the old one for a sample, but you go to the engine room at night or some other time when it is not running, take out the old piston and rod, measure them up and put them back in place once more, so they can be kept in service until the new parts are ready.

From these measurements secured in haste in this way the new piston and rod must be made, making due allowance for increased diameter of the new piston if the cylinder is to be re-bored, which is usually the case.

Now, all of this presents no difficulty except the screw thread; but in this particular if you simply measure its diameter at top or bottom, or both, and also its pitch—as near as you can—you will find about three times out of five, that the new rod will not screw into the crosshead more than about half way, because the pitch of the thread on the rod is not exactly the same as the pitch of the tap used in finishing the thread in the crosshead. Nor can the rough-and-ready methods of the repair man be blamed for this altogether, for it is a fact that if the new piston and rod are ordered from the builders of the engine, the thread is little or no more likely to be a fit, owing to inaccuracies in lead screws and error in the tap caused by hardening. And to find himself with a 24-inch piston on a 4-inch rod which won't screw into the crosshead and the nearest lathe big enough to handle the job 20 miles away, is an experience no man will care to repeat any oftener than he is obliged to.

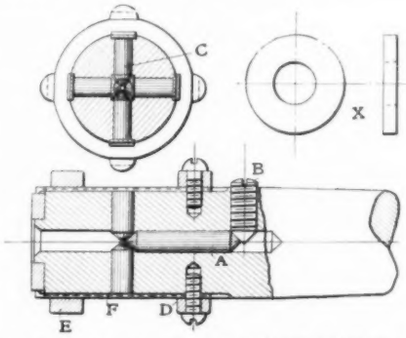
The gage shown consists of a piece, *A*, made of 1x¼-inch flat iron, with its two ends bent up about half an inch and filed to form two V edges, which should be 60 degrees, or the same angle as the threads, in order to fit fairly to the old thread. The distance betwen the two ends should be about equal to the length of the thread in the crosshead, in order that these V's may approximately represent in the gage the first and the last thread in the crosshead.

Another piece of the same flat iron is bent up, as shown at *B*, and riveted to the middle of *A*, its free end being bent over and brought into line with the two V edges and at such a distance from them than when a V point is filed on the free end of *B* the old thread will slip in between the three points. The piece *B* is finished by bending and filing the point until a good caliper fit is secured, and we now have a gage which not only gives us the diameter of the thread at one point, but gives us the *effective* diameter at the points where it is important for us to know it, and also provides us with the means of gaging the new thread, which may or may not be of the exact pitch of the old one but which if made to this gage, will screw in every time and make a fair fit, which is all that the repair man either expects or desires—and, in fact, is all that the builder did in the first place.

E. P. CLARK.

A Grinding Fixture for Bronze Washers.

This simple little fixture was designed to hold, for grinding, the bronze washers shown at *X*. These washers were to be



A GRINDING FIXTURE FOR BRONZE WASHERS.

face ground on both sides, and the usual form of expanding chuck was found wholly inadequate.

This fixture comprises an arbor made with a suitable taper to fit the head spindle of a No. 3 Landis Universal grinder, on which the work was to be done.

The center of the arbor is drilled out and fitted with a pin *A*, having a cone point at each end, the back part being about 100 deg., included angle, the back end of *A* is fitted to a headless set-screw *B* having a cone point of about 80 deg. The front end *A* is pointed to 80 deg. to

fit the four radial pins *C* having 100 deg. points, and it will be readily understood that inward movement of the set-screw *B* expands the four radial pins against four springs *F*. These springs are held in place by two collars *D* and *E*, fastened to the arbor by screws. The collar *E* is provided with four slots, relieved toward the inner face so as to allow the springs free expansion under the pressure of the radial pins.

The springs are provided at their outer ends with lips, the lips being formed to fit the circumference of the washers. The end of the arbor is turned to provide a center for the washers.

The washers come pretty true to size, so only a small movement of the spring jaws is necessary. M. B. F.

A Transparent Envelope for Drawings.

As drawings, completed or not, sent into the shop are apt to get dirty, my employer devised an envelope to prevent this. The back is bookbinders' board about ¼ inch thick, a strip of heavy filler board is put around three edges and transparent celluloid on top. These are fastened together with escutcheon pins clinched on the back. A copper rivet and washer at each corner is put in as an extra precaution.

The drawing is slipped in or out by the open edge. ROBT. A. LACHMANN.

Roller Bearings.

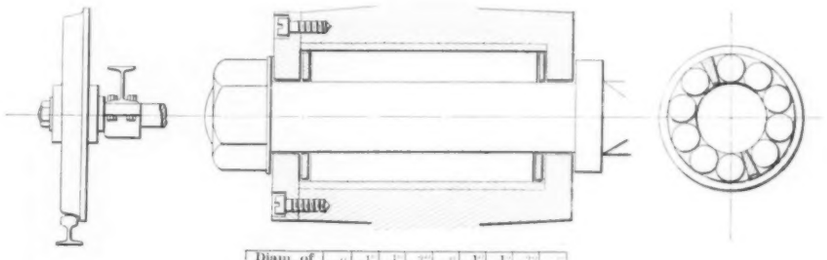
Without doubt the subject of roller bearings is one on which mechanical textbooks are very reticent and it is difficult to find any reliable information and data in periodicals; but having personally seen many experiements carried out with roller bearings, I will endeavor to give some of the important particulars which go together to make a satisfactory job.

The experiments were carried out with trucks and carriages bearing loads and running on rails, and also on the ground, and proved that roller bearings, if correctly and accurately made, are a great power saver against plain bearings, insomuch that they reduced the traction force between 60 and 70 per cent. The experiments also showed that cages were almost a necessity if satisfaction and a minimum amount of attention were expected, and also if their lasting properties were to be studied. In fact, if cages were used and the bearings properly designed, there should be no fear whatever of their causing inconvenience or trouble of any kind.

The bearing giving the greatest satisfaction is rather expensive; but, like most machines, if reasonable first cost is not grumbled at, the expense is amply and quickly repaid in the majority of cases through the absence of repairs, etc. It is not the design which is the cause of this high cost, but the extreme accuracy which is required in machining and fitting, as no shoddy methods will do—these bearings requiring exactness to a greater degree than ball bearings.

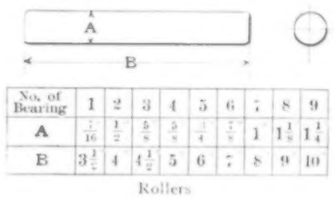
The proportion of the shaft to the rollers should be about 2 to 1, and it is important that this should not be increased or decreased any great amount. The shaft should be of mild steel, case-hardened and ground to size, the allowance after grinding being from exact size to 0.001 inch under size. The rollers should be of good carbon steel with ends well rounded, hardened and ground, and caged in sets of not more than 4 or 5 (better results following when even smaller sets are used), with a total clearance in each set of from 0.18 to 0.2 of one roller diameter, decreasing proportionally to the number of balls per set.

The wearing surface for the rollers in the boss of the wheel consists of a steel bushing, not quite so hard as the rollers or shaft, driven into the boss, and with washers placed on either side to prevent the rollers and cages from falling out and for the ends of the cages to bear against.



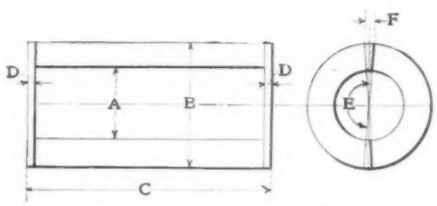
Diam. of Shaft	1"	1¼"	1½"	1¾"	2"	2¼"	2½"	2¾"	3"
No. of Bearing	1	2	3	4	5	6	7	8	9
No. of Rollers	9	10	9	11	10	10	10	10	10

Arrangement of Bearings



No. of Bearing	1	2	3	4	5	6	7	8	9
A	1/16	1/2	5/8	5/8	3/4	7/8	1	1 1/8	1 1/4
B	3 1/2	4	4 1/2	5	6	7	8	9	10

Rollers

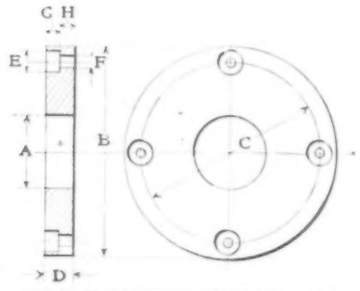


No. of Bearing	1	2	3	4	5	6	7	8	9
A	1 1/16	1 5/16	1 1/16	1 13/16	2 1/8	2 3/8	2 5/8	2 7/8	3 1/8
B	1 11/16	2 1/16	2 11/16	2 15/16	3 1/8	3 1/8	4 1/8	4 1/8	5 1/8
C	3 13/16	4 1/16	4 1/16	5 1/16	6 1/16	7 1/16	8 9/16	9 9/16	10 9/16
D	1/8	1/8	3/16	3/16	3/16	3/16	1/4	1/4	1/4
E	180	180	130	164	180	180	180	180	180
F	7/32	3/16	3/8	5/16	7/16	1/4	5/16	1/4	1/4

Cages

No. of Bearing	1	2	3	4	5	6	7	8	9
A	3 1/8	4 3/8	5	5 1/2	6 1/2	7 1/2	8 5/8	9 5/8	10 5/8
B	2 1/8	2 1/2	3 1/8	3 1/8	3 1/8	4 3/8	5	5 1/2	6
C	1 1/8	2 1/4	2 1/4	3	3 1/2	4	4 1/2	5	5 1/2
D	1/8	1/8	3/16	3/16	3/16	3/16	1/4	1/4	1/4

Bushes



No. of Bearing	1	2	3	4	5	6	7	8	9
A	1 1/32	1 9/32	1 17/32	1 25/32	2 1/32	2 9/32	2 17/32	2 25/32	3 1/32
B	3 1/8	3 3/4	4 3/8	5 1/8	5 7/8	6 5/8	7 1/2	8 1/4	9
C	2 3/8	3 1/8	3 7/8	4 1/4	4 7/8	5 1/2	6 1/4	6 7/8	7 1/2
D	3/8	3/8	1/2	1/2	5/8	5/8	3/4	3/4	7/8
E	3/8	3/8	1/2	1/2	1/2	5/8	5/8	3/4	3/4
F	3/16	3/16	1/4	1/4	1/4	5/16	5/16	3/8	3/8
G	3/16	3/16	1/4	1/4	5/16	5/16	3/8	3/8	7/16
H	3/16	3/16	1/4	1/4	5/16	5/16	3/8	3/8	7/16

Washers

DETAILS OF ROLLER BEARINGS.

The cages are made of white or gunmetal, and it is also not necessary to harden the washers, for which cast iron may be used if a special design is required.

Proper access should be allowed for lubricating and a right method used, as bad lubrication goes very hard against the most perfectly designed bearing.

To sum up, the greatest item of importance—and one which should have prece-

dence above all others—is the exactitude of the diameters of rollers and shaft and of the bore of the bush, the allowance for which should be the same as the shaft, namely: exact size and 0.001 inch under size. As regards the rollers, these should be ground true to half a thousandth of an inch. If these accuracies are not obtained, some rollers will bear when the others do not, thereby distributing the load unevenly, although each roller should have a sufficient crushing resistance to withstand the whole load.

I append tables referring to different sizes of roller bearings, which are self-explanatory. TROCHEE.

Cone-Pulley and Other Machine Molding.

I found in a recent number* an article on molding machinery by a correspon-

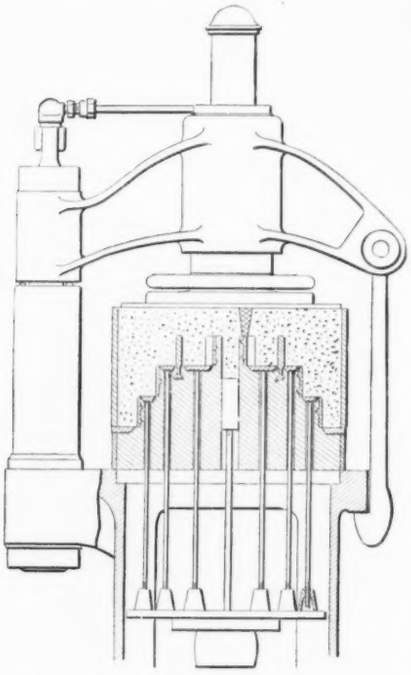


FIG. 1. MOLDING THE CONE PULLEY ON THE "UNIVERSAL" MACHINE WITH STATIONARY BASE.

dent of yours, and I wish to give you my views on the subject.

Your correspondent seems to divide molding machines into the following classes; Machines for ramming the sand only; pattern drawing machines, hand ramming; roll-over machines; special machines.

Your correspondent says that the first† class is convenient for "jobs" that have an unusually crooked form and the third one for other work, such as that which has a green-sand core in the drag with very little supporting surface. As to the fourth

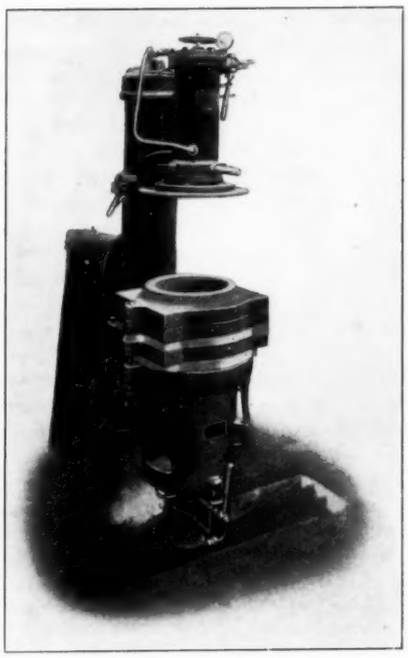


FIG. 2. ROTATIVE MOLDING MACHINE R-4 PATTERN IN PLACE, FOR MAKING THE DRAG OF MOLD FOR A POT.

class, which includes all special machines, let us put it aside for the present though much can be said on this subject. These divisions seem to me rather arbitrary.

By this classification your correspondent makes it look as if the power machine can very seldom be a pattern drawing machine or more correctly a stripping-plate machine. This, I believe, is true for most of the machines you are accustomed to see in the States, the reason being that in pattern-drawing machines, if the stripping

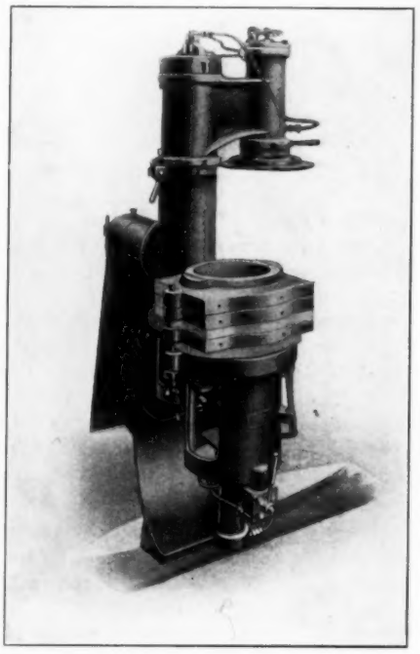


FIG. 3. HEAD-PIECE SWUNG TO SIDE, READY TO PUT FLASK AND SAND IN PLACE.

plates are strongly supported the patterns are mounted on a plate having a down motion supported by levers and cannot be strong enough to support the tremendous shocks produced by the compressed air ramming almost exclusively used in the States. Much could be said on this subject and in my opinion compressed air is not at all fitted for the work demanded in a molding machine. Hydraulic pressure is far superior in all respects and the only reason air has been selected in the States for operating molding machines is probably that air mains were available in most foundries when molding machines were designed. Hydraulic pressure is used almost exclusively in Continental Europe generally at 750 pounds per square inch.

The main advantages of hydraulic pressure are: convenience in design on account of the relatively small area of rams; possibility of giving a steady pressure

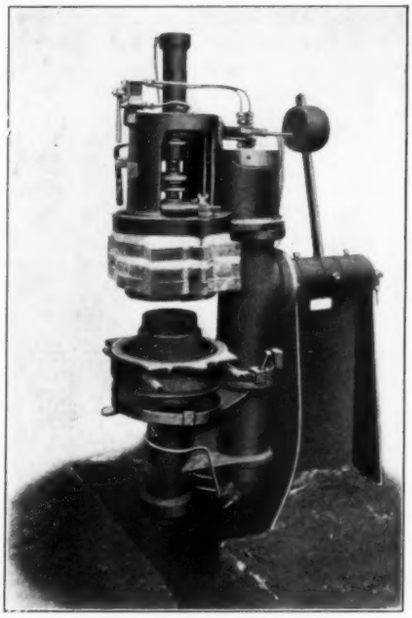


FIG. 4. MACHINE SWUNG AROUND 180°; AND MOLD WITHDRAWN FROM PATTERN.

at one stroke without shocks; steadiness and full control of motions as well for ramming as for drawing patterns.

Your correspondent gives a few questions that he says each buyer must consider before buying. From these questions and also his illustration of making a cone pulley with gears inside I conclude that we have entirely different views on the question, which is quite natural, having different materials to work from.

I send along a sketch of the said cone pulley (Fig. 1) to illustrate how I would solve the case. First of all I find that the drag, on account of the deep pocket, should have been made on a roll-over machine, should this machine permit the use of stripping plates. The said machine in its usual form does not allow the use of strippers, so your correspondent has been obliged to use a bar in the molding box

*P. 388, Vol. 28, part 2. The publication of this letter has been held up so long on account of the delayed arrival of the illustrations.—Ed.

†This is perhaps a mistake for "second."—Ed.

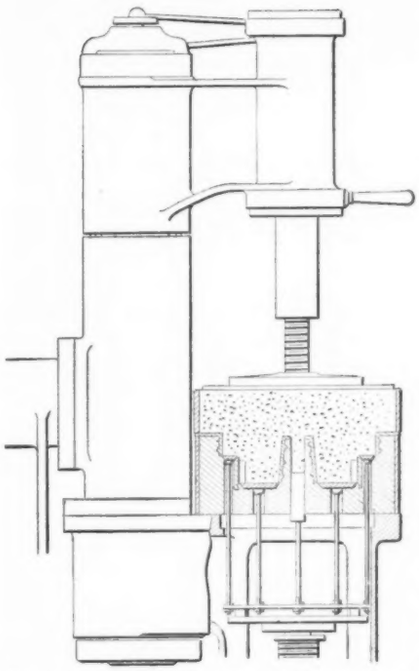
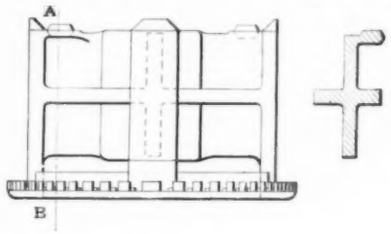


FIG. 5. MOLDING THE CONE PULLEY ON THE ROTATIVE MOLDING MACHINE.

(flask) which is of course a difficulty for power ramming.

For this class of work there has been designed a rotative machine* in which we ram the mold in a similar way (though simpler than that your correspondent describes) but using power hydraulic ramming. Then the entire machine is caused to revolve half a revolution around a horizontal axis while the mold is under pressure. Upon putting the cylinder to exhaust the mold is gently



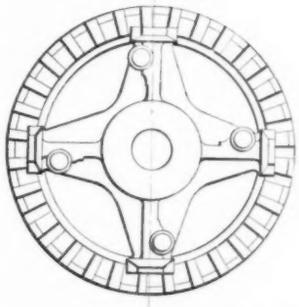


FIG. 6. DYNAMO SPIDER.

lowered and the stripping plates attached to the drawing ram follow far enough to set the mold free from the pattern.

I send you three photographs (Figs. 2, 3, and 4) showing a similar operation for the drag of a pot mold.

To give you an idea of the output that can be obtained in this way I might mention that the drag of the core part of such work is usually made at a much greater speed than the cope, which is rather surprising. I send you a sketch of the arrangement of the machine with the pattern plate as I should make it (Fig.5).

You will notice that I would make the central cylindrical core with the mold and that the method of making the pattern plate is entirely different from the method described by your correspondent. The pattern plate is placed on the table of the molding machine and in consequence is strongly supported. The external parts of the pattern and stripping plates are a shell of non-contracting metal and the body is plaster of paris.

No doubt that, if, instead of a cone pulley, which is a rather simple pattern where nearly all work can be done on the lathe, another casting like the dynamo spider for which I send you a sketch (Fig. 6) had to be made the cost would have been enormous and probably would have prevented making it by machinery.

In the same number of your paper (p. 391) you publish an article by G. P. Campbell describing molding by hand of a casting like a hanger for shafting. I do not desire to bother you with my views on the question but I would make this casting in quite a different way. I would put one piece only in each box and would use a hydraulic machine with stripping plates. By doing so I would make more molds and they would be light enough to be carried away by one man, which is much quicker, when it is possible, than any system of mechanical handling.

If I had to make an arrangement similar to the one shown in the article I would use what we call here the system of reversible pattern-plate appliance and make the pattern plate in non-contracting metal and plaster, which would cost much less than the wooden pattern plate and stripping plate described and is much better for the use.

E. RONCERAY.

Paris, France.

*We have in preparation a description of the rotative molding machine.—Ed.

Standard Screw Threads for Electrical Apparatus.

Referring to the article by E. R. Douglass, at page 817, recommending that a standard fine thread be adopted by manufacturers of electrical apparatus, the attached schedule will probably be of interest to your readers as it outlines the practice of one of the largest manufacturers. This table was adopted some four years ago, after requirements of manufacture had been very clearly demonstrated, and since its adoption it has not been necessary to make or use special taps or threads other than those listed.

The list of threads proposed in the article referred to above, I do not believe would meet the varied requirements of electrical manufacture, although there would be advantage in the general adoption of a uniform table.

JOHN W. UPP.

Diame'r.	U. S. St'd.	Fine.	Very Fine.	Brass and Copper Nuts for Contact Studs.
¼″	20	32	42	U. S. Standard
5/16	18	30	40	
3/8	16	27	36	
7/16	14	24	32	
½	13	20	32	
9/16	12	20	32	12
⅝	11	18	32	12
¾	10	16	30	12
7/8	9	14	30	12
1	8	12	24	12
1⅛	7	12	24	12
1¼	7	12	24	12
1⅜	6	10	24	14
1½	6	10	24	12
1⅝	5½	10	20	12
1¾	5	8	20	12
1⅞	5	8	18	12
2	4½	8	16	12
Fine threads for all sizes above 2″ diameter to be 8 per inch, and very fine 16 per inch.				12 Threads Standard for Sizes Above 2″ Diameter.

FINE AND VERY FINE SCREW THREADS FOR ELECTRICAL APPARATUS.

Systematic Economy in Making Drawings.

The opinion given at page 546 in "Systematic Economy in Making Drawings," by G. F. Summers, makes me think, if I may say so without intending rudeness, that the author has not worked in a drawing office where there is no definite system of checking. My experience is short, but I have worked in the drawing offices of fair-sized and well known engineering firms. In the first, all drawings, etc., were checked at least twice. During my stay there I never heard of a mistake being allowed to slip through. In the second, there was no such system, and mistakes, sometimes bad ones, occurred almost daily. For personal comfort alone there can be no question as to which is the best of the two methods. By no means waste money in the drawing office, but take care how you save it, for unless exceedingly well thought out, an attempt to cut the costs may prove disastrous. Above all things do not drive your draftsmen; time is less valuable in the drawing office than in the shop.

JAY PAITCH.

Birmingham, England.

Judging from current reports with reference to the slow progress on the East River tunnels, the Pennsylvania Railroad will have a superabundance of time for experimenting with electric locomotives for its New York terminal. One of the locomotives is now in service on the Long Island Railroad, of which many miles are equipped with third rail; another electric engine is receiving its equipment at the Westinghouse works, East Pittsburg.

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Testing that Tests.

It is a familiar fact that many accidents to engineering structures of various kinds, buildings, bridges, machinery, etc., are due to incomplete knowledge (on the part of the engineer or designer) of the materials of which the structure was composed, or, in other words, to more or less complete ignorance of those materials. Calculations based upon materials of a certain strength, having shown the structure to be safe, have gone wrong because the materials were not what were calculated upon.

The testing of materials is of course designed to give complete knowledge of the materials tested; or at least such complete knowledge as is necessary for the designer to know, or such as has any bearing upon the strength, durability and reliability of the structure to be made. If the tests do not give such complete knowledge, the designer may of course be deceived. He thinks he has what he has not; with the result, very often, that money is wasted, and lives needlessly sacrificed. It goes without saying that tests should tell everything that it is at all important to know so far as it affects the purpose for which the material is to be used, and no other sort of test can be called a test in any proper sense of the word.

Most manufacturers know how to test the materials which they produce, and are able to say in any given instance whether or not they are really giving a material which in every way meets the requirements of the specifications. But for much the same reason as applies to the Chicago packers, there must be independent inspection and tests of structural material, and this inspection and testing must be done on behalf of the buyer or his engineer; experience having shown that it is not safe to leave it to be attended to by the maker of the material. Human nature does not and will not stand such a test; with here and there, of course, an honorable and unusual exception. The tendency of makers generally is downward, where materials are supplied which are simply to be accepted upon the responsibility of another, and for which the maker is, after their acceptance, not be held responsible. It is for this reason that we hear so much of "commercial tests" being made too rapidly, and of the uselessness of determining the elastic limit, and the yield points of steel to be used in structures.

So far as the proceedings at the recent meeting of the American Society for Testing Materials are concerned, the so-called and in some quarters despised "professorial class" made a much better showing than was made by the representatives of the manufacturing and commercial interests. Practically all the propositions and arguments in favor of sloppy and incomplete testing—testing which would enable the manufacturer to furnish practically any sort of material he might choose to furnish under a given specification, came from men who would call themselves practical men—acquainted with business and manufacturing in a practical way; while most of the propositions intended to insure that tests shall test, and that when a test has been made, an inspection of its results will enable an engineer to know the characteristics of the material tested, came from the professors. Granting, if you please, that these two classes of men are equally honest and conscientious, that most of them intend to do what is right; yet it must be said that the professors are not influenced by considerations directly affecting their own pocketbooks; they look at these things from a purely engineering and scientific standpoint; they are in a position to know what is the right thing to do, and they are free to advocate the doing of that thing and the refraining from the doing of anything else. They have no special temptations in favor of the profitable way as against the safe and honorable way.

A notable example of the tendency among large manufacturers was shown in the discussion on the testing of locomotive springs. Here it was shown that different interpretations of tests, or different methods of testing, pursued at the present time, give widely varying results, and that unless the designer knows just how the test was made, he may have little idea of what result a given spring will give in use, or whether or not it will act as he intended. In the course of the discussion it was announced, as though it were a matter of course, and as though no one would question its entire propriety, that what is known as the "surging test" had been abandoned for such springs, because they were now produced in such large numbers that it was impracticable to apply this test to them. Now the surging test is of such a character that it actually tells what a spring will do when in actual service, and the contention that it cannot now be applied, because springs are produced in such large numbers, is absurd upon the face of it. It obviously costs no more to apply the surging test to a locomotive spring today than it did when they were made in smaller numbers; and indeed if we are to judge from other analogous things in manufacturing operations, it would probably cost less to apply these tests today than it formerly did. The only real reason such tests are not applied now is that it is desired to save the money it would cost to apply them, and a cheaper test has been adopted, the manufacturer first adopting it, and being allowed to use it, forcing his competitors to adopt the same thing, or go out of business. Here is just where the testing engineer should come in. He knows that the surging test is the right one and the only one which tells the facts about a spring. He should insist that such a test should be applied, and the road employing

him should pay the price necessary to apply such test.

The claim that because many more springs are made now than formerly, therefore springs may be made and should be accepted upon a test which shows almost nothing of what they will do in service, appears in its true light when we imagine a similar condition to obtain in the machine-tool business. Let a lathe, a milling-machine or a grinding-machine builder say, "When I made machines in small numbers I could afford to carefully test them to see that they were accurate and satisfactory in every way, but now that I make them in large numbers it is manifestly impossible for me to apply such careful tests." The absurdity of such a claim is at once seen. There is just as much reason why a lathe, a miller, or a grinder should be carefully tested now, as there was when they were made in smaller numbers; just as good an opportunity for testing them, and no builder would think of claiming, because his production is now large, that it is impossible for him to apply a test which he regularly applied when his production was small.

We shall not claim that such pleas are not set up by tool builders for the reason that tool builders are *per se* more honest than makers of steel, but let us suppose that it is only because the buyers of machine tools have abundant opportunities for determining as soon as the machine goes into use, whether it is accurately built or not, and whether it is what it pretends to be or not; whereas, in many cases the buyer of steel which goes into structures of various kinds has no means of knowing what he is buying, until a breakage occurs which results in serious loss, and perhaps the death of one or more persons.

The society named above aims to stand for manufacturing, for engineering, and for testing interests. It will, however, fail of its duty unless it stands up for thorough and honest testing, testing which will show what it pretends to show about the materials tested, testing which will enable the engineer in making his calculations, to know whether he has gotten what he has calculated upon or not, and there should be no accepted excuse for sloppy, incomplete or deceptive testing on the ground that production has now become so large that it is no longer possible to thoroughly test materials. The claim will not bear investigation, and if thorough, complete testing is not to be done, then the thing to do is to acknowledge that it costs too much, and that customers will not pay for it. The plea that it cannot be done because production is too large is absurd.

In the proportion of passengers killed to the total number on the train, the accident which occurred at Salisbury, England, to the special steamer train, carrying passengers from the steamer "New York" to London, has seldom been surpassed. Among the people killed were two well known in machinery circles. Louis Cassier, publisher of *Cassier's Magazine*, was instantly killed, as was also the son of the late Mr. Smith, of Smith & Vaile, manufacturers of turbine water wheels. The young man was a senior in Yale university.

Taximeters Needed Here.

Those Americans who have been in Paris and Berlin and have enjoyed the privilege of riding in cabs, which have a taximeter upon the seat, the dial of which faces the passenger and indicates continuously the amount of his bill at any given moment, have wondered why this system of the machine computation of cab fares has not been introduced in this country. It would seem from a report sent in by our Vice Consul General A. E. Ingram regarding this matter, that it cannot be due to lack of pecuniary success, because he says that the introduction of these machines has resulted in very much larger use of cabs and in increased receipts for both the cab companies operating them, and for the drivers. The taximeter certainly reduces the chances of trouble and misunderstanding to the minimum and the introduction of such things in connection with the New York cab service might seem a subject worthy of the attention of our Merchants' Association. Though New York, it is true, is well supplied with trolley lines, elevated roads, subways, etc., it is nevertheless also true that probably cabs would be very much more used if there were considerably less risk of difficulty with the men who drive them, and this risk is almost entirely eliminated by the little machines referred to.

Again a workman, this time in the Homestead Steel Works, has been killed by compressed air being forced into his body by a joking fellow-workman. It would seem to be wise for the makers of compressed-air tools to suggest to every customer that he have notices posted about the works stating the danger of playing with or perpetrating practical jokes with compressed air, and that when these notices have been duly posted, those who continue to play with it should be held legally responsible for the consequences of their acts.

It is getting to be almost as difficult to keep track of "the largest steamship" as it was to keep track of the biggest locomotive until the construction of the immense Mallet compound established a record in the latter line which is likely to hold for some time. The recently launched quadruple-screw Cunarder, the "Lusitania," is 785 ft. long over all, 760 ft. between perpendiculars, breadth molded 88 ft., depth 60 ft. 6 in., gross tonnage 32,500, draft 33 ft., displacement 38,000 tons, designed speed 25 knots, and is to be propelled by steam turbines with a total indicated horse-power estimated at 68,000. Now it is announced that the Hamburg-American Line is going to eclipse this vessel, as well as its own "Amerika," with a steamship 800 ft. long on the water line, 90 ft. beam, and a gross tonnage of 35,000; the new steamer is to be completed in 1908.

New Enterprises in Cincinnati.

It is announced by a Cincinnati paper that a number of manufacturing concerns, chiefly interested in the machine-tool industry, have become affiliated in an enterprise looking to the establishment of an industrial community near Cincinnati, the scheme including several large manufacturing plants, with also a large number of residences for workmen. One hundred acres of ground have been obtained for the purpose at Oakley. The Cincinnati Milling Machine Company, The Triumph Electric Company, the Cincinnati Planer Company, and the Bickford Drill Company are interested and will erect new works upon the property. Plans are being drawn for some of these new improvements and an effort will be made to have the plans represent the latest and best things in machine-shop construction.

The New Trade-Mark Act.

The amended trade-mark Act which becomes operative July 1, provides that the owner of a trade-mark residing in the United States, or in a foreign country having a trade-mark treaty with the United States, may obtain registration for the trade-mark by complying with the following requirements:

First, by filing in the patent office a written application specifying his name, domicile, location and citizenship; the class of merchandise and particular description of goods comprised in such class to which the trade-mark is appropriated; a description of the trade-mark itself when needed to express colors not shown in the drawing, and a statement of the mode in which it is affixed to goods, and the length of time during which the trade-mark has been used. With the statement shall be filed a drawing of the trade-mark, signed by the applicant or his attorney, and such number of specimens of the trade-mark as actually used as may be required by the commissioner of patents.

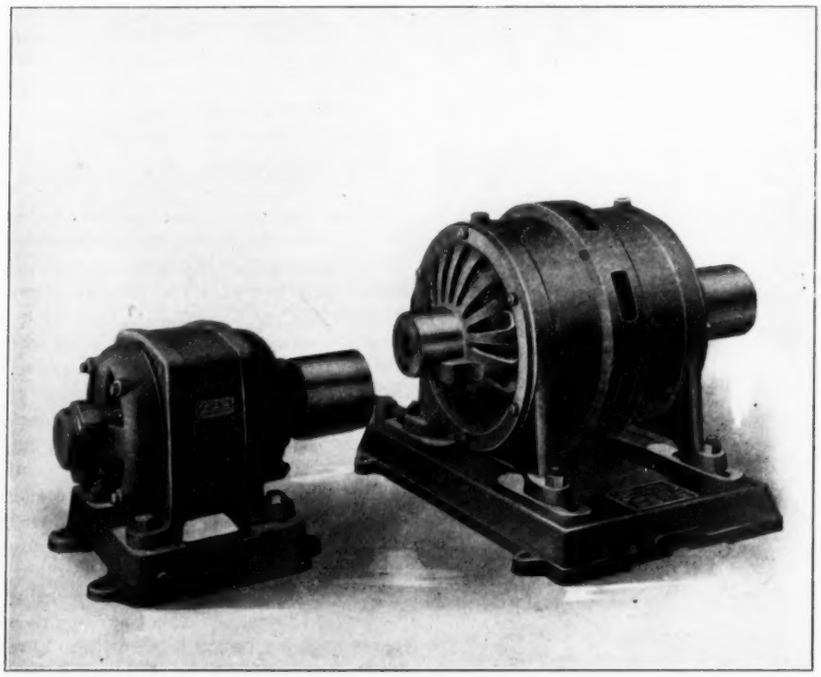
Second, by paying into the Treasury of the United States the sum of ten dollars.

Classes of merchandise are established by the commissioner of patents for the purpose of trade-mark registration, and he is to determine the particular description of goods described in each class.

New Tools and Machine Shop Appliances.

A NEW LINE OF SMALL INDUCTION MOTORS.

The accompanying illustration shows a new design of polyphase induction motor which is made in sizes from 1 to 7½ horse-power by the Stanley G. I. Electric Manufacturing Company, of Pittsfield, Mass.



THE NEW STANLEY INDUCTION MOTOR.

The motor is shown alongside a Stanley induction motor of the same power as made fifteen years ago in order to illustrate the remarkable reduction in size which has been brought about. This reduction is partly due to the advance of electrical science in the meantime and partly to the elimination of non-active material and the provision of better facilities for dissipating the heat.

In the older design the motor is completely surrounded by a frame or box of cast iron, which not only increased the bulk and weight but impeded the radiation of the heat. In the newer construction this box is omitted, the laminated punchings being clasped between the frames in such a manner that their outer surface is directly exposed to the air. The end shields are bolted to the frames by four bolts, whereby the shields may be secured in four positions and the feet, which are cast with the frame, be bolted to the floor, ceiling or wall. The bearings are self-alining and are fitted with ring oilers.

A TACHOMETER.

A new portable tachometer has been brought out for registering the revolutions of motors, generators, shafting, etc., and for indicating the miles per hour of automobiles.

The instrument consists of a reservoir, a small centrifugal pump and a hydrostatic column. The only moving part is the paddle wheel in the centrifugal pump.

The reservoir is filled with pure alcohol, colored with aniline dye; it connects with the center of the pump. From the periphery of the pump there are passages to the hydrostatic column or indicator tube.

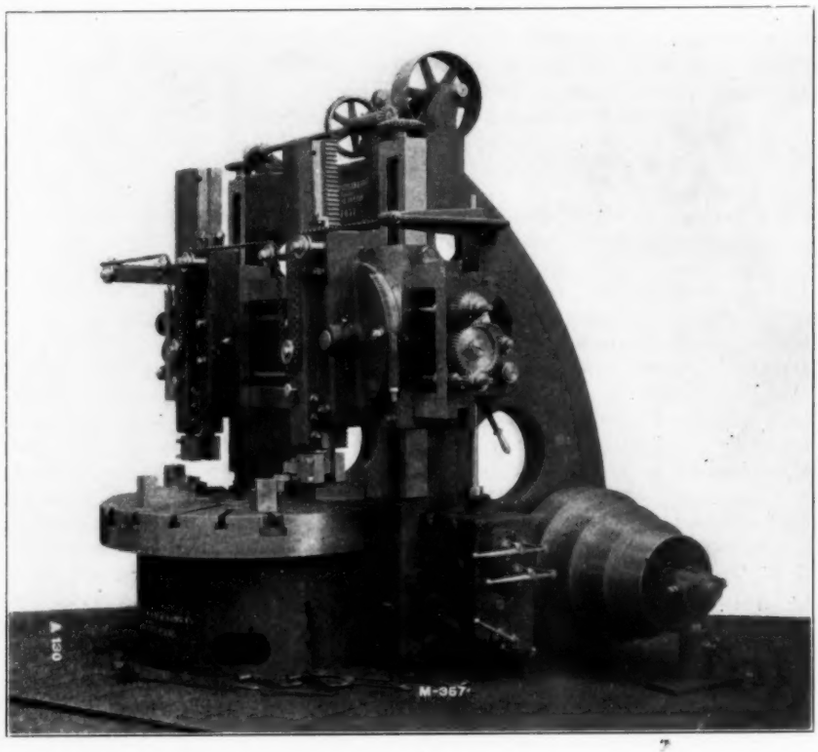
The ratio of vertical hights of the surfaces of the liquid in the indicator tube and in the reservoir will be approximately proportional to the square of the speed of the pump.

The position of the reservoir with relation to the indicator tube is such that a slight inclination of the instrument does not affect its accuracy. A throttle is provided between the pump and the indicator to prevent the vibration of the column due to sudden fluctuation in speed.

This instrument is made by the Veeder Manufacturing Company, Hartford, Conn.

HEAVY TIRE MILL.

The accompanying illustration shows a new design of heavy boring and turning mill for tire work which is the recent product of the Bertram Works, Dundas, Ontario, of the Niles-Bement-Pond Company. The machine is driven by a 6-inch belt on a 4-step cone with back gear and 2-speed countershaft, giving 16 changes of speed. Eight positive feeds are provided which are controlled by a gear box, the range being from .03 to .41 inch horizontally and from .03 to .38 inch vertically. The heads are independent in all their movements and both may be brought to the center of the table for boring. The cross rail is raised and lowered by power and the table is of sufficient depth and has cross ribbing to make the machine self contained.

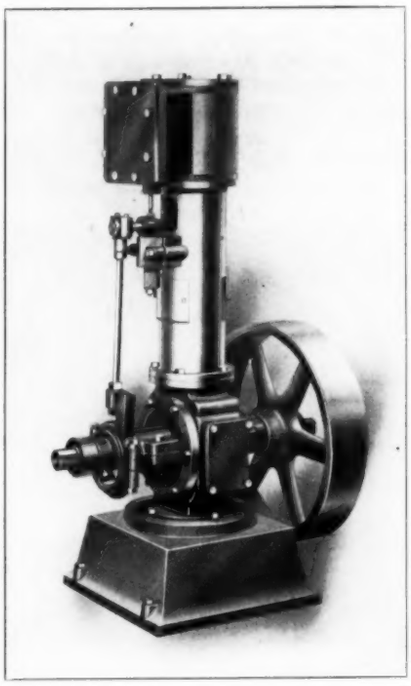


HEAVY TIRE MILL.

The diameter of the table is 49¾ inches, the swing being 51 inches. The extreme capacity under the tool is 23 inches and the tool bars have 32 inches vertical travel.

A VERTICAL ENGINE.

The illustration shows an engine which has recently been brought out. The feature which has been kept in view by the designer is to have all parts as easy of access as possible. The journal boxes are bored and bushed with bronze. The slide



A VERTICAL ENGINE.

valve is of the double-ported type with pressure plate. These engines are equipped with automatic governors, and are bulit in sizes from 5 to 15 h.p. by the M. E. Howard's Machine Works, 374 and 376 South Senate avenue, Indianapolis, Ind.

AN INSTRUMENT FOR DRAWING SPIRAL CURVES

Fig 1 shows an instrument for drawing spirals and circles.

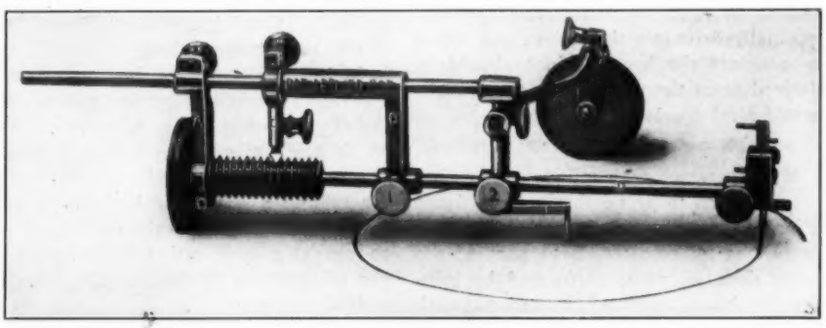


FIG. 1. AN INSTRUMENT FOR DRAWING SPIRALS AND CIRCLES.

Fig 2 shows some of the spirals and circles drawn by the instrument. The hob or screw and the roller resting on the table at the left determine to a certain extent the pitch of the spiral; the other element upon which the pitch depends is the distance the roller is from the center; obviously the roller will take more turns to go around the circumference of a large circle than that of a small circle. The pointer shown engaged with the hob can be thrown out of contact and the lower bar carrying the pen can be clamped when it is desired to produce circles. Spirals of any pitch from 1/16 to 4 inches, and any radius from 1/16 to 18 inches, can be produced with a set of six hobs.

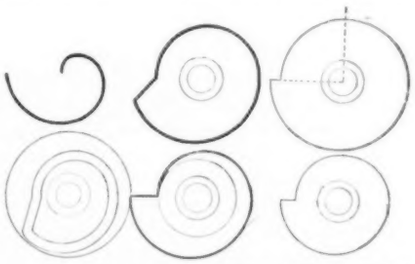


FIG. 2. SPIRALS AND CIRCLES PRODUCED BY THE INSTRUMENT.

Any circle up to 36 inches diameter can be produced.

The instrument is the invention of A. G. Fenn and is made by him at Chicopee Falls, Mass.

CHIP FENDER.

Edward L. Finn, of 12 Clark street, Torrington, Conn., is making a chip fender, to be applied to lathe tools, which is intended to prevent the exceedingly hot chips made by modern high-speed steel from striking the operator in the face. It has a metal frame which attaches readily to any turning tool, and this holds a piece of heavy plate glass which does not interfere with the workman's view, but prevents injury.

An admiralty order has been promulgated according to which employees in the royal dock yards of England commenced working a 48-hour week on July 2. It is announced that this regulation is to be tried for a year, at the end of which time officials will report upon its operation. Eight and a half hours will be put in on the first four days of each week, nine hours on Fridays and five hours on Saturdays, the dock yards closing at noon on that day.

High-Speed Steel.

At the June 6 meeting of the Boston Branch of the National Metal Trades Association, papers on high-speed steel were read by Eugene Childs, of the Tri-mont Manufacturing Company, and W. T. Sears, of the engineering staff of the Niles-Bement-Pond Company. We abstract the following from Mr. Sears' paper:

With reference to the saving made by the use of alloy steels in place of common carbon steel, there are three general cases:

First, removing metal (hard or scaly) that common carbon-steel tools practically would not touch.

Second, removing a great deal of metal in a short time, due to the ability of the alloy steels to stand up under speeds and feeds far greater than carbon-steel tools.

Third, removing small amounts of metal which carbon-steel tools would do as well perhaps, the saving being due to longer life of these tools and ability to hold their edges for a greater length of time.

For the first case there can be no argument, and the writer has seen chilled gray iron planed at two feet a minute with alloy-steel tools, the iron being of such hardness that common carbon-steel tools failed to make any practical impression whatever. The saving under this head is, undoubtedly, rapidly on the increase, one reason being that the steels are found to cheapen work of this class heretofore done in some other manner, and another is that the possibility of machining this sort of material is permitting it to be used to a greater extent than heretofore.

As regards the second case, there is, of course, no argument, and this is the field in which alloy steels made their entry and proved their powers. I do not think anyone for an instant questions the economy of the alloy steels for this work.

THE COST OF A TOOL.

The third case is one which possibly many firms have failed to estimate on correctly. Leaving out of consideration the question of money invested in tool steels, which is a comparatively small item in the average shop, the actual cost of a cutting tool for finishing a piece of work is the cost of the amount of this tool used up in doing the work. This tool cost has been presented in a number of different ways by different writers, but for a rough comparison of tool steels as good a method as any is to compare the totals made up from the sum of the first cost and cost of maintenance of the tool in proper cutting condition. The first impression a man would get if he were offered two tools of different steels that would do identically the same amount of work, one of which was ten cents per pound and the other twenty, is that the first would be twice as economical a steel as the second. The actual facts are, how-

ever, that when cost of maintenance is taken into consideration the difference would probably be nearer 9 to 10 than 1 to 2, or, in other words, the first cost is of very little moment. It is, of course, necessary to assume that practically all the steel is used up and none scrapped. For instance, when a tool has been used down to the shortest efficient limit on one machine it is to be drawn out to smaller sizes and used on smaller machines. I would, therefore, repeat that the price chargeable to the tool is the first cost plus putting into proper cutting condition plus maintenance in that condition. Under this last item would be the cost of delays to the machines and the work on the machine, etc. For instance, we will assume a specific case. Take a tool 1½x¾ inch, assume that it costs four cents per cubic inch if of carbon steel and sixteen cents per cubic inch if of alloy steel. Assume that at each grinding it loses about 1/16 inch in length, or 1/14 cubic inch, and that after each ¾-inch loss in length due to grinding it must be re-dressed and loses in this process ¼ inch. Then for each inch used up there would be twelve grindings and one tool dressing. A very conservative estimate of the time lost through the grindings would be 40 minutes and for dressing 20 minutes, or one hour; the cost of grinding would hardly be less than 20 cents and dressing 15 cents, a total of 35 cents. This gives in the neighborhood of 30 cents per cubic inch for maintenance of tool in good condition. The comparative cost of these tools to the user then would be 30 plus 16 equals 46 to 30 plus 4 equals 34, or as 23 to 17 in place of 4 to 1. There is no doubt that the above estimates are extremely conservative when all losses, many of which are omitted, have been taken into account and that the actual ratio is still less, even allowing that the alloy steels would cost a little more to keep in proper condition than the common carbon brands.

SPECIAL CONDITIONS.

In view of the above, it is the writer's opinion that there are very few places indeed where the proper use of alloy steel will not effect a saving, although, of course, there are cases where there is apparently nothing, or at least very little, saved by such steels. To illustrate, there was a case brought to the notice of our company in drilling deep holes in steel locomotive frames. It was found that at high speeds the chips would not follow the grooves, with the result that drills of any steel were broken. It was necessary, therefore, to reduce the cutting speeds to such an amount that common carbon steels gave satisfaction and the statement was made that the actual cost of doing the work with them was somewhat less than with drills of alloy steel. This is a special instance and one not often met with.

About a year ago a shop with which the writer was formerly connected began experiments with the use of alloy steels for riveter dies, and recent reports were that they were proving very satisfactory and effected quite a saving, although no definite figures on the subject were given.

The writer knows of no cases where this steel has been tried for work in which it would be subject to impact as, for instance, dies in pneumatic riveters, but where it is subjected to simple pressure of upsetting hot rivets or similar work it would be reasonable to suppose that it would hold its shape and turn out satisfactory work much longer than dies made of common carbon steel.

Tests show that there is a saving in power in using the alloy steels. Up to date there have been no tests which show any fixed ratio, but the saving is there. It requires less power per cubic inch of metal removed to cut at 60 feet per minute than it does at 25 feet with the same area of cut. Also, for removing large amounts of metal an increase of area of cut is more economical than an increase of speed.

We find in our shops, for average work on fairly hard machine steel, that we cannot go much over 100 feet a minute with the average alloy-steel tool with an area of cut of 0.004 square inch. We cut higher than this when testing, but in most of our work we find 100 feet about the limit. For planer work on cast iron, on a 120-inch planer, we find 30 feet about the limit; rising to 40 to 50 feet on small planers on light cuts; 60 feet is usually too high. We have taken with four tools 0.84 square inch in cast iron, at 33 feet per minute, on our 120-inch planer, with a special drive.

The following notes are from Mr. Childs' paper:

One of the peculiar features of the high-speed steel question is that when making tests, which are carefully supervised, records are made which in regular practice are never matched. The operator on the lathe finds it so much easier to change to a slower speed than to bother with the tool dresser, that unless the matter of cutting speeds is carefully watched, it will be found that the workman will gradually drift into the slower and easier speeds, and the benefit which should be derived from the use of high-speed, high-priced steel ceases to be apparent.

HIGH-SPEED STEEL FOR MILLING CUTTERS.

My experience with milling cutters has been such as to prove that we could not afford to use the simple carbon steel at any or at no cost. A large part of the work done by us is performed by milling machines, operated in groups, with the speed so adjusted that the operator is allowed just time enough to get to each machine when the cut is complete. In some cases the cutting speed has been increased very little, and the benefit derived from the use of high-speed steel is seen in the length of time the cutters will run without re-grinding. In many cases cutters run from five to nine days at one grinding. This feature is of special importance where gang cutters are used, which have to be re-adjusted at each grinding.

When first starting to use high-speed steel, at the suggestion of the maker of the steel, we built a special furnace, adapted to heat a pot filled with slag in which the cutter was heated. The difficulty experienced in heating by this method was that the slag adhered to the surface of the cutter, thus preventing the quick cooling of the metal. At the present time we are using an oil-fired furnace, and are getting very good results by that method. We have tried various mixtures for cooling, but find that the best results have been obtained by a bath of lard oil.

The range of temperature to which the steel should be heated is very narrow, and the best results can only be obtained by the use of a pyrometer.

I cannot do better than to give a few of the records made by cutters in regular operation:

For jaw-threading operations, the cutters are made from a disk five inches in diameter by 15/32 inch thick. The cutting teeth are formed and ground on the face. The cutters are run at a peripheral speed of 107 feet per minute, with a surface feed of the jaw of 14 inches per minute. After the cutters are ground back to a point where the teeth are too thin, they are recut to a smaller diameter.

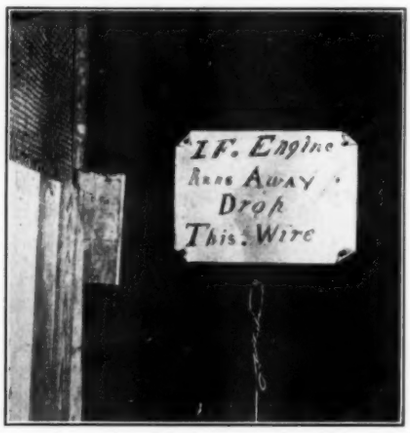
The records of cutters are as follows: A new cutter threaded 870 jaws, when the teeth became too thin for use. After re-grinding and tempering, 1460 jaws were threaded before becoming too thin. The number of jaws threaded at each grinding figured from 100 to 330. These cutters are hardened in oil, without drawing the temper. The stock operated on is a high-carbon steel, well annealed. The depth of the cut will average about ⅛ inch. An inserted-tooth cutter, used for facing, with a feed of 3½ inches per minute, running at a peripheral speed of 218 feet per minute, ran nine days without re-grinding. Condition at end of run, fair. A pair of cutters, taking a straddle cut in high-carbon annealed steel, running at a peripheral speed of 75 feet per minute, and a feed of 2 inches per minute, ran 50 hours before re-grinding. Condition at end of run, good. A cutter used for milling a slot ¾ inch deep, ¼ inch wide, running at a peripheral speed of 90 feet per minute, with a feed of 2 inches per minute, ran 67 hours. Condition at end of run, good.

The cutters by which these records were made, were heated to as high a temperature as possible, without damaging the surface of the metal, hardened in lard oil, and tempered in an oil bath to a temperature of 445 degrees Fahrenheit.

Echoes from the Oil Country—An Engine Safety Attachment.

As I turned around and started for the door, there in front of me in plain sight, where it could not well be overlooked, was a sign that was rather suggestive. The photograph will show what it is like. It is not so very long since I read of some engine running away and doing a great deal of damage, and as this seemed to be meant for a safety device I had to investigate. An examination of the photograph will show the degree of art expended in its production. While not exactly a thing of beauty, it is very legible. The wire referred to is directly under the sign, and can scarcely be overlooked even by a man in a hurry.

There is one drawback to it, and that is that the street door is close at hand, and



THE VISIBLE END OF THE SAFETY ATTACHMENT.

a nervous person might be tempted to hasten out of it instead of following the plain and simple directions of the sign. After looking around it was very evident that the best place at hand had been selected, and it was impossible to get to that door without going directly toward the notice. While there is no explanation given as to why the wire should be dropped it is a justifiable conclusion that good will come from it, and then it is an easy thing to do so. The wire is hung on a nail and runs down through the floor. A slight pull forward removes it from the nail, and the only other thing necessary is to let go of it.

Evidently the front passage of that shop is not much frequented by boys, or other people of an investigating turn of mind, or it is likely that the wire would some time be dropped without very close regard as to whether the engine was really running away or not. The engine was not running at all when I first saw the sign, so that I had no excuse for dropping the wire and noting results, and while getting permission to photograph the sign I learned more about it than I would have done had I dropped it.

The present occupant of the building disclaims any credit for the device as he found it there in working order when he took possession.

The engine referred to is a gas engine. It runs the machinery in a little shop that is attached to a junk yard. The shop is on the level of the street, and the sign is in the entry which leads into the shop and also to the room partitioned off to act as an office. Part of the partition can be seen at the left of the picture. The engine is about ten or twelve feet under the floor, partly under the building and partly under the sidewalk. To get at it from the floor above it is necessary to go down some very steep and narrow stairs which end under the sidewalk in a very dimly lighted place. From there, after much twisting and turning, and a liberal use of matches, by following the sound the engine will be found working away in the dark. Here I found it on the occasion of my second visit, in a space without a ray of outside light. An open gas jet was lighted so that I could see the engine and the safety device.

For all its seeming crudity, this device really deserves its name, "safety device," for it is reliable. The engine is without a governor. A cock in the gas line has been furnished with a forged handle about a foot long. The wire is attached to this handle, and when the wire is on the nail the valve is wide open. A liberal supply of old iron securely wired to the handle is ready to close it whenever allowed to do so by the wire. I do not know of any way that a gas engine can be made to run with its supply of fuel cut off, and after being there I am very sure that I would rather drop that wire than to hunt in the dark for the runaway engine.

The running of such an engine without a governor is not as reckless as it might at first appear to be. It is of the type known around here as a "converted" engine, that is, it is a steam engine with a gas cylinder put on in place of the steam cylinder. The utmost speed that could be gotten out of it would not be at all likely to cause it to damage itself, but it might cause unpleasant vibrations in the building, the upper story of which is a tenement.

This device has stood the test of time as it has been in use for several years, and is still in good working order. As the same engine and the same building are still there we have proof that it has never failed in justifying the faith of its designer. If I went on to tell of all the good things that could be said of it some one might think this a patent medicine ad.

It is neither patented nor copyrighted.

W. OSBORNE.

Personal.

Oberlin Smith, president of the Ferracute Machine Company, Bridgeton, N. J., has gone to Europe and will be absent about two months.

Thomas Newall, for some time past foreman of the tool room of The American Pin Company, Waterbury, Conn., has been appointed assistant superintendent of the above named concern; while Henry Kast has been appointed foreman of the tool room in place of Mr. Newall.

Olaf Saugstad has established himself at 13-21 Park Row, New York, where he will practice as consulting and designing engineer, making a specialty of temperature and pressure regulation in all branches. During the last three years Mr. Saugstad has been connected with the Davis & Roesch Temperature Controlling Company, and the H & M Automatic Regulator Company as master mechanic and superintendent. He resigned his position with the latter company in June, but is still looking after the mechanical end of their business part of the time, to help them out until they can make other arrangements.

Business Items.

The Hess-Bright Manufacturing Company, because of increased business, has been forced to secure larger quarters and will in the future be located at the northeast corner of Nineteenth and Hamilton streets, Philadelphia, Pa.

The Boston offices of Niles-Bement-Pond Company and Pratt & Whitney Company have been removed from Pearl street to more spacious and handsomely furnished quarters on the eight floor of the Oliver Building, corner of Milk and Oliver streets. The policy of these companies is to dispense with showrooms, the variety of both heavy and light machine tools and cranes built by their several works being too great to permit of exhibition.

Manufacturers.

The Niagara Metal Works, Buffalo, N. Y., is building a $50,000 addition.

The New Haven (Conn.) Carriage Company will build a new boiler house.

The Macungie (Pa.) Brass and Manufacturing Company will erect a new plant.

Bridgeford & Company, stove foundry, Louisville, Ky., will erect a new factory.

The Brown-Lipe Gear Company, Syracuse, N. Y., has started work on its new plant.

The Ideal Foundry Company, Grand Rapids, Mich., will build a new molding shop.

The Price Baking Powder Company, Chicago, Ill., will erect a new $100,000 factory.

Hunter Brothers, Fulton, N. Y., are shortly to build another pulp mill at Battle Island.

The Baltimore & Ohio Railroad will build two new roundhouses in Washington, D. C.

The Collins & Wright Company, Pittsburg, Pa., metal spinners, will erect a new plant.

The Fairmont (W. Va.) Foundry Company, a new concern, has chosen a site for its plant.

Plans have been completed for a $100,000 addition to the Lenoir Car Works at Lenoir City, Tenn.

The Creamery Package Manufacturing Company, Port Washington, Wis., will erect a new $90,000 plant.

The Standard Sanitary Manufacturing Company, Louisville, Ky., is to build an addition, to cost $25,000.

A machine shop will be erected for F. J.

Stokes, Philadelphia, Pa., at Seventeenth and Cambria streets.

The National Drug Company, Philadelphia, Pa., will erect a new plant, including a one-story engine house.

The American Fruit Product Company, of Rochester, N. Y., is erecting a cold-storage plant in Gates, N. Y.

The Horton Manufacturing Company, New Haven, Conn., making steel fish rods, will build a three-story addition.

Contract has been let for the construction of another building for the National Cash Register Company, Dayton, Ohio.

The Kemp & Burphee Company, Syracuse, N. Y., will build additions, which will include a three-story brick power house.

Blake & Johnson, machinists, Waterbury, Conn., have bought land in Waterville with the intention of building a plant.

The Charles Abresch Company, Milwaukee, Wis., will erect a four-story addition, to be devoted to the manufacture of automobies.

The Mica Insulator Company, Schenectady, N. Y., is perfecting plans for the erection of a new and larger plant to cost over $100,000.

The Steele & Johnson Company, Waterbury, Conn., making stamped brass goods, is preparing plans for an additional four-story factory.

The Metropolitan Ice Company has been incorporated at New Orleans, La., with a capital of $125,000. Charles D. Cottrell is president.

The Iowa Hard Wall Plaster Company has been incorporated at Davenport, Iowa. J. B. Butler, J. J. Ryan and others, stockholders.

The Petroleum Iron Works Company will move its plant from Washington, Pa., to Sharon, where a $500,000 plant will be erected.

Eugene Dietzgen Company, Chicago, Ill., manufacturers of surveying instruments, etc., has secured a permit for a four-story factory building.

The Covel Manufacturing Company, of Chicago, Ill., which makes patent file-room machinery, etc., will move to Benton Harbor, Michigan.

The Aragon Cotton Mills has been incorporated at Rock Hill, S. C., with a capital of $350,000. Alexander Long, of Rock Hill, is president.

The Puritas Ice Company is being formed in Mexico City, Mexico, with a capital of $180,000. H. H. Adler is one of the chief promoters.

The city council of Humboldt, Kansas, has granted a franchise to V. G. Shinkle and others to build and operate an electric lighting system.

Ground has been broken for the $50,000 addition to the plant of the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.

The Federal Furnace Company, Chicago, Ill., is constructing two buildings to cost $100,000. One is a power plant and the other a casting house.

J. W. Kelly & Company, Chattanooga, Tenn., will spend $25,000 in improvements at its bottling works. Modern bottling machinery will be installed.

The Westinghouse Consolidated Foundries Company, Trafford City, Pa., will greatly enlarge its plant and move the Cleveland and Allegheny plants there.

The Wentworth-Kloke Showcase Company, Omaha, Neb., has been incorporated with a capital of $100,000. Lew Wentworth and R. F. Kloke, incorporators.

The National Wire Corporation, New Haven, Conn., is contemplating the erection of an addition to be used for rolling ingots from steel made in the plant.

The Hanson & Van Winkle Company, Newark, N. J., manufacturing platers' and polishers' supplies, is making extensive alterations and additions to its plant.

C. P. & J. Lanson, manufacturers of gas engines, etc., Milwaukee, Wis., will erect another factory, where they will manufacture portable gasolene engines.

Fire caused a damage of $10,000 to the plant of John Rausenberger Company, Milwaukee, Wis., manufacturers of cordage. The burned portions will be rebuilt.

Stone & Webster, of Boston, Mass., have started work on a new power plant on the White river, in the State of Washington, which will cost over $1,000,000.

The Hawkeye Plaster Company has been organized at Fort Dodge, Iowa, and will erect a mill. J. F. McNamara, Frank McNamara, M. A. Dunuombe are stockholders.

The St. Louis (Mo.) Coalette Fuel Company has been incorporated. Capital, $500,000. A $200,000 plant will be erected. C. W. Renfrow, of Joplin, Mo., is interested.

The Union Twist Drill Company, Athol, Mass., has let a contract for a three-story brick building, the business of the company being such as to demand this enlargement.

The Anderson Coupling and Supply Company, Kansas City, Mo., manufacturing hose and fire-department equipments, will erect a new factory to cost between $75,000 and $100,000.

The American Air Brake Company, capitalized at $1,500,000, is seeking a location in Pittsburg, Pa. Mr. Coleman, of Coleman & Walker, Pittsburg, has charge of securing the plant and site.

The Richmond (Va.) Gasolene Engine Company, just incorporated with a capital of $30,000 to build the "Little Wonder" gasolene engine, is in the market for factory equipment. Address, General Manager, Box 734, Richmond, Va.

The Clinton Sugar Refining Company has been incorporated with a capital of $1,100,000, its principal place of business to be at Clinton, Iowa. Charles A. Williams, Harry K. Allen and Edward A. Rogers, all of Chicago, are incorporators.

The Scott County Garbage Reducing and Fuel Company, a new concern, is erecting a plant in West Davenport, Iowa, where it will manufacture machines for the reduction of garbage, and also a fuel similar to coke. The company's offices are in the Winecke Building, Davenport.

Catalogs.

Wilber Emery, Oberlin, Ohio. Booklet describing barbed wire machines. Illustrated, 5x6, pp. 12, paper.

Utica Drop Forge and Tool Company, Utica, N. Y. 1906 catalog of nippers and pliers. Illustrated, 6x9, pp. 32, paper.

Crocker-Wheeler Company. Bulletin No. 67, illustrating and describing Form I-F variable-speed motors. 7½x10, pp. 12.

Ingersoll-Rand Company, 11 Broadway, New York. Pamphlet, Form 6-A, describing pneumatic tools. Illustrated, 3x5½.

Ph. Bonvillain & E. Ronceray, Paris. Catalog describing universal system of machine molding. Illustrated, 6x9, pp. 36, paper.

The Clark Automatic Telephone Switchboard Company, Providence, R. I. Catalog describing apparatus made by this company.

Colburn Machine Tool Company, Franklin, Pa. Catalog B, describing the new Colburn universal saw table. Illustrated, 6x9, pp. 20, paper.

T. R. Almond Manufacturing Company, 83-85 Washington St., Brooklyn, N. Y. Circular illustrating and describing the Almond coupling.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 2007, describing "Imperial" piston drills. Illustrated, 6x9, pp. 36, paper.

The New Britain Machine Company, New Britain, Conn. Booklet describing "New Britain" band-saw filer. Illustrated, 3½x6, pp. 14, paper.

Edwin H. Ludeman & Co., 42 Broadway, New York. Catalog of engines and boilers handled by this company. Illustrated, 8½x11, paper.

Scott & Sons Co., Medford, Mass. Circulars illustrating and describing "Ess Ess" quick-opening chuck and "Red Devil" automatic self-opening die.

De La Vergne Machine Company, foot East 138th Street, New York. 1906 Catalog of refrigerating and ice-making machinery. Illustrated, 6x9, pp. 47, paper.

The Wellman-Seaver-Morgan Company, Cleveland, O. Catalog Section "C," describing open-hearth and re-heating furnaces. Illustrated, 9x12, pp. 48, paper.

Aktiebolaget Alpha, Stockholm, Sweden. Pamphlet describing machine for testing hardness according to the Brinell ball-test method. Illustrated, 6x9, pp. 12, paper.

The Billings & Spencer Company, Hartford, Conn. 1906 catalog of patent improved drop hammers and other forging machinery. Illustrated, 5x7½, pp. 43, paper.

Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass. Bulletin No. 149, illustrating and describing polyphase induction motors, small sizes. 8x10, pp. 8.

Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. Circular 1132, illustrating and describing Westinghouse protective apparatus. 7x10, pp. 23, paper.

C. Drucklieb, 132 Reade St., New York. Pamphlet entitled, "Sandcraft," which contains notes on connecting and operating the injector and sand-blast apparatus. 3½x6, pp. 12, paper.

Chambers Brothers Company, 52nd and Media streets, Philadelphia, Pa. Catalog L, describing automatic paper feeders and paper folding machines. Illustrated, 6x9, pp. 36, paper.

E. W. Bliss Company, Brooklyn, N. Y. Catalog describing machinery for the manufacture of armature disks and segments, electrical instruments, fittings, etc. Illustrated, 5x7, pp. 52, paper.

Norton Grinding Company, Worcester, Mass. Catalog of Norton plain milling machines for cylindrical grinding. This is well printed and has very fine half-tone illustrations. 6x9, pp. 55, paper.

Karl Krause, Leipzig, Germany, (Louis De-Jonge & Co., 69 Duane street, New York, U. S. agents). Catalog of paper-making, printing, bookbinding, box-making machinery, etc. Illustrated, 6x9 pp. 345, cloth.

Oswego Boiler and Engine Company, Oswego, N. Y. Bulletin No. 40, illustrating and describing steel tanks for gas, gasolene, air and water for use as blow-off, receiving, drip, pressure or hot-water tanks. 6x9, pp. 15.

Landis Tool Company, Waynesboro, Pa. Catalog entitled, "Landis Grinders—How to Use Them." This contains a good deal of information about the use and operation of grinding machines and should be of value to those interested. Illustrated, 6x9, pp. 75, paper.

Ingersoll-Rand Company, 11 Broadway, New York. Catalog D 43, describing Rand rock drills and mountings for mines, quarries and tunnels. Illustrated, 6x9, pp. 53, paper. Catalog X 136, of "Imperial" Type Eleven power-driven air compressors. Illustrated, 6x9, pp. 28, paper.

American Locomotive Company, 111 Broadway, New York. Catalog of electric motor and trailer trucks. Illustrated, 6x9, pp. 58, paper. Pamphlet entitled, "Locomotive Tests," which is a compilation by Dr. W. F. M. Goss from a publication by the Pennsylvania Railroad entitled, "Locomotive Tests and Exhibits." Illustrated, 6x9, pp. 55, paper.

Fort Wayne Electric Works. Bulletin No. 1079, describing direct-connected type MPL direct-current generators for power and lighting. Illustrated, 8x10½, pp. 12. Pamphlet No. 5010, "Summer Comforts," which describes the "Wood" fan motors. Illustrated, 4x9, pp. 23, paper. Flyer 4503, "Solid Comfort," illustrating and describing fan motors.

Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass. Bulletin No. 612 (superseding No. 254), on G. I. flush push-button switch. Illustrated, 6x9, pp. 4, paper. Bulletin No. 148 (superseding Nos. 141 and 146), on polyphase induction motors. Illustrated, 8x10, pp. 20, paper. Bulletin No. 613, describing type "K" arc lamps. Illustrated, 6x9, pp. 16, paper.

Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. Special publication No. 7049, describing alternating and direct-current motors. Illustrated, 6x9, pp. 16, paper. Circular No. 1129, illustrating and describing No. 119 railway motor for direct-current service. 7x10, pp. 16. Circular No. 1134, illustrating and describing electrical and mechanical brakes for Westinghouse type K motors. 7x10, pp. 11.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Agents to sell all kinds of counting machines. R. A. Hart, Battle Creek, Mich.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—9 or 11-inch engine lathe, 4 or 5-ft. bed, for general repair work. Address *Evening Leader*, New Haven, Conn.

Wanted—Work for an 84-inch Bickford boring mill; can furnish castings. Fulton Machine & Vise Co., Lowville, N. Y.

Wanted—Copies of the AMERICAN MACHINIST for July 6 and August 31, 1905. State price. J. H. Cole, Windsor, Vt.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Mechanical engineer, about to start in business, desires agency for some salable machinery or article in the mechanical line. Box 791, AMERICAN MACHINIST.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Wanted — To purchase machinery and shop equipment necessary for manufacturing balls for ball bearing. Address offers to D. 238, Annoncen Expedition of D. Schürmann, Düsseldorf, Germany.

Want manufactured on a royalty, and for self to sell, fruit and vegetable parer and slicer; pares potatoes successfully; weight, 3 lb.; castings, 1 lb. steel; patent applied for. W. R. Phillips, 131 Perry St., Trenton, N. J.

Well known and old-established firm in Birmingham, England, doing business with all the large engineering works, is anxious to take up the sole agency for some specialty worth pushing. Highest references given. Box 780, AMERICAN MACHINIST.

Specialties—We make on contract, specialties for marine, automobile and general use, and do general machine-shop work on small brass goods. Lovell-McConnell Mfg. Co., Currier Bldg., opp. Pennsylvania Railroad Station, Newark, N. J.

Post-office Box 252, Atlanta, Ga., desires to purchase a jib crane suitable for very severe work; mast should be not less than 25 feet in hight nor over 28 feet; jib to be 30 feet, giving crane a radius of 60 feet; either belt power, hydraulic or electric type will answer. Give price and best delivery, either new or second-hand.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/5 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Company, 1036 Majestic Bdg., Detroit, Mich.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Size B Franklin portable crane; good condition; cheap. Rockfur, Box 793, AMERICAN MACHINIST.

For Sale—Excellent machine-shop building, with power, in Philadelphia; 60x90 feet, three stories, solid ground floor. Box 545, AM. M.

For Sale—Foundry, machine and boiler shop, well equipped and in operation, in one of the best growing towns of Oregon; good opportunity for a competent manager of limited means to acquire a substantial interest. Box 761, AMERICAN MACHINIST.

Business Opportunities.

A company manufacturing a machine which has been sold to, and accepted by, the U. S. Government, and which has no effective competition to meet in this and other important markets, desires to increase its capital by interesting someone who believes in what is known as industrial betterment. Answers are requested from principals only. Address "Betterment," care American Institute of Social Service, 287 Fourth avenue, New York.

For Rent—Three-story brick and stone factory building with large brick manager's house and horse barn on grounds. Factory equipped with two 20 h.p. Smith turbine water wheels, two 11½ kw. Westinghouse D. C. generators. Fire protection on each floor. The most beautiful and healthful town in Pennsylvania. Cheap help—no manufacturing competition. Good railway and trolley facilities. Equipments all new, never used. Apply to T. A. Willson, Ephrata, Lancaster Co., Pa.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Position wanted by an experienced mechanic who can build special, new, improved machinery for valve manufacturing, and who is an expert in dies, fixtures, etc. Address P. O. Box 95, Bridgeport, Conn.

ILLINOIS.

Superintendent or assistant—Young man, excellent mechanic and executive, thoroughly familiar with modern methods, has responsible position with large manufacturing company in Chicago, desires to change to smaller, cleaner location anywhere; might sacrifice present salary. Apply Box 785, AMERICAN MACH.

MASSACHUSETTS.

Draftsman wants work. Have had experience in gun, sewing machine, textile machinery, and tools and fixtures for manufacturing economical and interchangeable. Box 770, AMERICAN MACHINIST.

Technical graduate with 10 years' shop experience desires a beginner's position in a drawing room, with chance for advancement; have natural inventive ability. Box 790, AMERICAN MACHINIST.

NEW YORK.

Mechanical expert, draftsman, estimator, competent to improve, build automatic tools and machinery. Box 792, AMER. MACHINIST.

Position wanted by experienced superintendent and buyer; intricate work; rapid production, with interchangeability, cost, stock, and tool systems. Box 773, AMERICAN MACHINIST.

Wanted — Position in publicity department of manufacturing establishment in Eastern territory; experienced in the preparation of copy and with the details of cut making and printing. Box 681, AMERICAN MACHINIST.

OHIO.

Superintendent or general foreman, practical gas-engine builder, 15 years' experience, age 36, American, open for engagement September 1. Address Box 787, AMER. MACHINIST.

Gas-engine builder, American, age 36, thoroughly practical, 15 years' experience, solicits correspondence with manufacturing company contemplating manufacturing gas engines for automobiles, railways, mines, or stationary. Address Box 788, AMERICAN MACHINIST.

WISCONSIN.

Position as superintendent, assistant superintendent or general foreman by young mechanic of character and ability; technical graduate, foundry and general machine-shop practice, 14 years' experience, 9 on gas and gasolene engines; ambitious, energetic, hustler; understands modern up-to-date methods; gas-engine work preferred. Box 786, AMERICAN MACHINIST.

Position by superintendent desiring change; 40 years, perfect health, extensive experience on special and automatic machinery, tool building and designing gas, gasolene, producer and producer engines; advertiser's forte is putting old and new plants in shape to produce a maximum of high-grade work at a minimum direct or indirect cost, based on simplest and most practical of modern ideas; A-1 reference; go anywhere. Address Box 789, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Wanted—Several competent all-around jobbing machinists. The Eastern Machinery Co., New Haven, Conn.

Good machinists wanted—Bench and lathe hands. Apply, stating age and experience, to The Boesch Mfg. Co., Danbury, Conn.

Wanted—A first-class man as foreman of a machine shop for building new and improved machinery. Must have executive as well as mechanical ability. Give experience, reference and salary expected. Address Box 796, AMERICAN MACHINIST.

DELAWARE.

Wanted, draftsman—Young man, one familiar with printing-press work preferred. E. L. Jones & Co., Dover, Delaware.

ILLINOIS.

Wanted—Foreman of experience for manufacturing small, intricate, interchangeable parts. Must have executive ability and be able to make machinery and operators work at maximum efficiency. Write fully giving age, experience and wages wanted. Address Box 795, AMERICAN MACHINIST.

Wanted, draftsmen — We want capable draftsmen of either electrical, mechanical or general experience. If you would like to change your position or its location, write and tell us about the character and extent of your work. Address, giving full particulars, to Western Electric Company, Dept. N. 29, Chicago.

MASSACHUSETTS.

Wanted—Five or six good machinists for fine machine work. Apply to Union Twist Drill Co., Athol, Mass.

Wanted—One toolmaker, three machinists on auto work, and expert gear-cutting man. Box 738, AMERICAN MACHINIST.

MICHIGAN.

Machine-shop foreman—Wanted, a competent machinist to take charge of the die and tool-making department of a large factory; applicants must show actual experience as foreman and must have a thorough knowledge of die designing and drafting. Address Box 744, AMERICAN MACHINIST.

MINNESOTA.

Wanted—A competent foreman of wide experience to take charge of the machine shop in a factory manufacturing D. C. and A. C. machinery; for the right man we have an exceptional opportunity. None but those who can get the work done need apply. Apply Box 783, AMERICAN MACHINIST.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

NEW JERSEY.

Wanted—Mechanical electrical draftsmen; only first-class men need apply. Box 508, AMERICAN MACHINIST.

Wanted—Machinist, first class, floor hands on heavy work, two lathe hands and two on boring mills, steady work, 54 hours per week. Box 794, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Draftsmen wanted for jig and fixture work. Apply Mergenthaler Linotype Company, 20-42 Ryerson street, Brooklyn.

Automatic screw-machine hands wanted for B. & S. machines; steady work at good pay. Apply 37 West 116th street.

Capable draftsman wanted for typewriter work; steady employment. Apply 37 West 116th street, New York City.

Milling-machine hands of experience wanted on duplicated parts. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—First-class men as toolmakers on punches and dies, also light high-grade jig and fixture work. Remington Typewriter Factory, Ilion, N. Y.

Wanted—Two draftsmen on small electrical apparatus; must have had shop experience, preferably at tool work. Address Box 778, AMERICAN MACHINIST.

Wanted—At once, one toolmaker and one foreman for machine room in factory running 20 to 30 men; in applying, state experience and wages expected. Box 771, AM. M.

Wanted—First-cass foreman for machine shop; must be able to handle men and produce work; also fairly versed in modern shop practice; give references. Address P. O. Box 73, Buffalo, N. Y.

Experienced machinist capable of taking charge as foreman of shop employing 40 to 50 hands. Must be capable of handling men, and a good executive. State experience in detail, and salary wanted. Box 797, AM. M.

Machinist—Must be familiar clock-work mechanism, some experience tool work; steady job, $3 day, 9 hours, near New York; excellent opening, certain advancement, pay and position for right man; state age, experience, etc., fully. Box 205, Larchmont, N. Y.

Wanted—Experienced draftsmen on dies, jigs and fixtures; also men capable of working out experimental drawings and machine details; factory pleasantly located in small town; permanent position to competent men. Address Box 781, AMERICAN MACHINIST.

We are permanently increasing our capacity and require the services of 10 mechanical draftsmen for detail work; attractive positions to suitable men; location, New York City. Address, stating age, experience and saary expected, Box 748, AM. MACHINIST.

Wanted—Foreman for factory manufacturing instruments of precision in large quantities; must be up-to-date in modern methods, well versed in interchangeable duplicate work and able to handle help to advantage; state age, experience, nationality and salary expected; also give references. Address A-1, Box 782, AMERICAN MACHINIST.

OHIO.

Wanted—High-grade machinist for engine work. S. M. Jones Company, Toledo, Ohio.

Several first-class draftsmen on detail and assembly drawings; state age, experience and salary. Box 746, AMERICAN MACHINIST.

Three or four competent mechanical draftsmen. In replying, give full information, including rate expected. Box 686, AM. M.

Mechanical draftsman, 23 years' practical experience on engines, special machinery, jigs and special tools; Ohio or Pennsylvania. J. H. Pillings, 77 Elm St., Cincinnati, O.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Machinists wanted—We are doubling the capacity of our plant and invite correspondence from first-class lathe, planer, boring mill and vise hands; also experienced gas-engine builders and testers; steady work and good pay to the right men. Address Superintendent, The Foos Gas Engine Co., Springfied, Ohio.

PENNSYLVANIA.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A few first-class machinists and toolmakers; also one or two automatic screw-machine operators for automobile work; steady work guaranteed. Address, giving experience, references and wages desired, The Autocar Company, Ardmore, Pa.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Pierce Mfg. Co., Woonsocket, R. I.

TENNESSEE.

Wanted—Machinist, toolmaker, three lathe and two planer hands; state experience and age. Southern Engine and Boiler Works, Jackson, Tenn.

Wanted—An experienced cost keeper for machine shop and foundry; state age, experience and salary. Location in Tennessee. Box 784, AMERICAN MACHINIST.

Wanted—Several first-class lathe hands; open shop; steady employment and good wages to competent men. Apply Duke-Success Machine Works, Memphis, Tenn.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., of Milwaukee, needs more patternmakers, machinists and moulders.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI.

Three salesmen, thoroughly experienced on machine tools and general line of machinery. We require successful men of highest ability, and only such need apply. Salary in keeping with requirements will be paid. Give full particulars as to previous positions and experience. Harron, Rickard & McCone, Los Angeles, Cal.

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Fosdick Machine Too Co.	16
Foss Gasoline Engine Co.	112
Foote, Burt & Co.	100
Frankin Mfg. Co., H. H.	111
Frankin Moore Co., The	116
Gang Co., Wm. E.	97
Gardner Eng. Co.	92
Gardner Engineering Co.	92
Gardner Machine Co.	92
General Electric Co.	106
General Pneumatic Tool Co.	117
Geometric Tool Co.	21
Gleason Works	4th cover
Goldschmidt Thermit Co.	110

Laying Out Cams on the Castings.

BY R. E. WEINLAND.

A great deal has been written about designing cams, but usually for the designer or draftsman rather than for the mechanic. It is seldom that we see anything showing how to get the cam outline on the casting or blank itself, and it is the object of this article to describe simple and practical methods for the mechanic to use in laying out ordinary cams.

Fig. 1 shows an ordinary face cam with a heart-shaped groove for giving a uniform motion of 2½ inches to the bar *B*. The travel of the roller is divided into any convenient number of parts, and the half circumference of the cam disk into the same number, circles through the former and radii through the latter giving points in the pitch line of the cam groove from which arcs having the same radius as the roller define the groove. I usually find it convenient to divide the throw into sixteenths, eighths or quarters and then divide the circumference into as many parts as I have fractions.

One of the most tedious things in laying out a cam is to scribe the profile curve. Not many machinists have an irregular curve in their box, and if they do they can hardly use it on a cam with a hub. A good way to scribe the curve is to take a piece of soft iron or lead wire and bend it until one side conforms to the shape of the curve desired, clamp it to the casting and scribe the curve. The dividing head of the milling machine can be used for making the divisions of the disk.

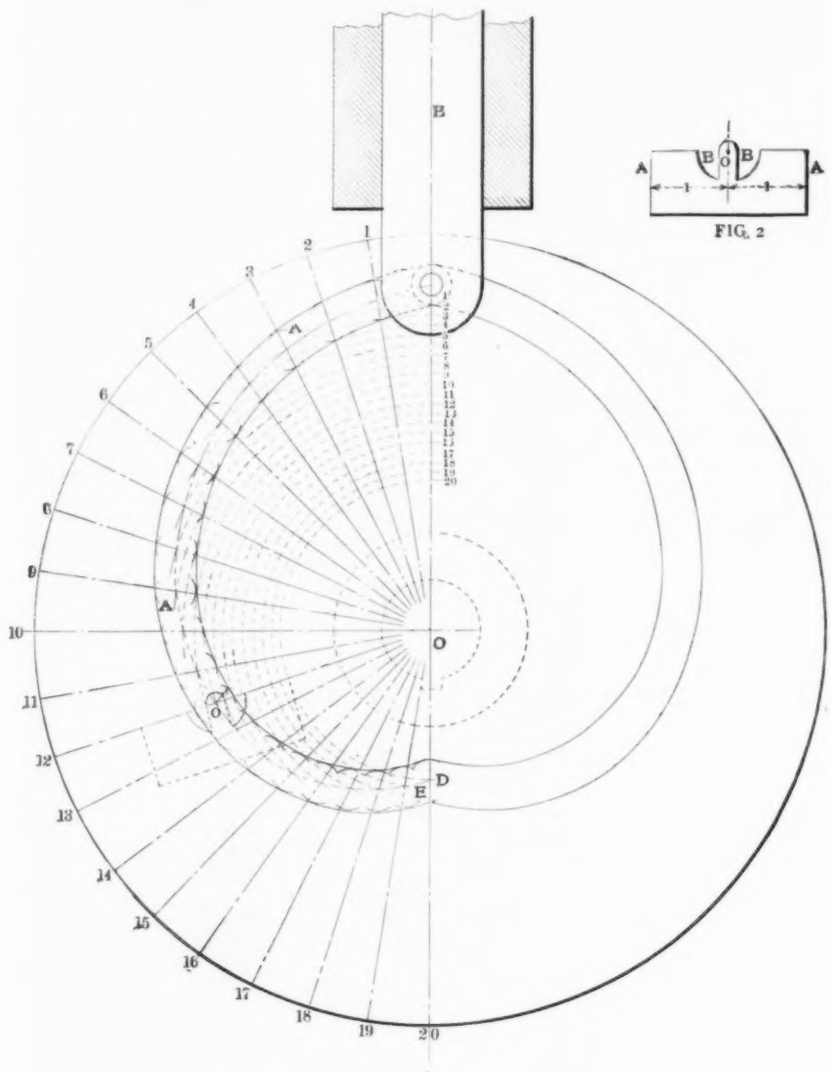


FIG. 1. LAYING OUT CAM CASTINGS.

FIG. 2

Laying out the cam shown would not be difficult because we have a plane surface and plenty of room, but suppose the groove to be in the casting and only to be machined out, or suppose we have an old cam that is badly worn in places, and it is desired to dress the groove out larger and use a larger roller. Then we have a different problem, for it will readily be seen that we have no centers from which to describe the small arcs that give the cam outline.

In this case take a piece of thin sheet metal, and make a piece like Fig. 2, which I call a center carrier. The method of using this piece is shown by the dotted outline at radius 12, Fig. 1. Since the centers for the roller arcs are gone we must provide something to take their places, and this piece answers the purpose. It can be made to suit one's fancy, the only requirements being that the center *O* be in line with the top edge of the piece, and equally spaced from each end, and that the spaces *B* and *B'* give ample clearance for the dividers. In this the distance from the center *O* to the ends *A* equals 1 inch. In laying out the cam proceed as usual, spacing the outer edge and drawing the radial lines, but in drawing the arcs 1, 2, 3, etc., locate them 1 inch nearer the center of the cam to allow for half the length of the center carrier, which is 1 inch. Next place the center carrier on the casting so that its top edge is on one of the radial lines as shown by the dotted outline in Fig. 1, and bring its end tangent to the proper arc; then using the center *O* of the center carrier describe the arcs that give the outline of the cam.

In Fig. 3 is shown a cam for the same movement as the one shown in Fig. 1, but intended for a spring return. This figure shows a casting with hub having a hole through it for the shaft, and only a small amount of metal on the edge to be machined off.

To lay out this cam we first turn the outside of the hub in order to get a true surface concentric with the hole for the shaft, and then make forty equal divisions on the disk around the hub. Dividing lines can be drawn from the hub to the outer edge, but by using the following method this is not necessary. Next get a piece of thin sheet metal and make two center carriers shown in Figs. 4 and 5, the radius of the arc being half the diameter of the hub of Fig. 3. These pieces should be made to fit the hub nicely, and after shaping them up as shown in Figs. 4 and 5, divide a certain distance along their edge (in this case 2½ inches) into the proper number of equal divisions (in this case 20) then with a very sharp punch make a small center on each line just as near the edge as possible. Place the center carrier on the casting as shown by the dotted outline Fig. 3, and describe the small arcs that give the cam outline. It will be seen that the small arcs representing the roller are tangent to the cam outline a little to one side of the dividing lines, which makes it possible to use a center carrier with a straight edge, having no clearance for the dividers and still get as much of an arc as we used. We can make one of these center carriers do for this cam by dividing both sides, but unless

it is made of very thin material the dividers will have to be set a little large to get the correct radius for the arcs representing the roller.

Turning now to Fig. 6, the roller *A* is fastened to the arm or lever *B*, which swings on the center *C*, the center of the roller describing an arc when in motion. Suppose the cam revolves in a right-hand direction; then during the first half of a revolution it will impart a downward motion to *B*; during the next quarter of a revolution *B* will remain stationary, and during the last quarter it will have an upward motion, returning to the original position. The motion is required to be harmonic.

To lay out this cam we will make, say, 18 equal divisions around the hub for the first half of the cam and nine for the last quarter. The third quarter need not be divided, as it is a true circle concentric with the shaft. We now make the center carriers Figs. 7 and 8. As will be seen, a great deal of the work of laying out is taken off of the cam itself and put on these pieces. To lay them out, we first draw the center line *O' A*, Fig. 8, set the dividers to half the diameter of the hub, Fig. 6, and, with *O'* as a center, describe the quarter circle *B b* and lay off the points *d D* the same distance from *O'* that *d* and *D* are from *O* in Fig. 6. Next set the dividers to the distance *C D*, Fig. 6, and with *d* and *D*, Fig. 8, as centers describe the arcs that interesect at *C* when with *C* as a center we describe the arc *d D* on the center carrier. With *A* as a center we then describe the half circle *d D*, divide this half circle into nine equal divisions and transfer these points to the arc as shown, thus obtaining the centers *a b c d*, etc., for the dividers for describing the small arcs that give the cam outline. This piece is for the last quarter on the right-hand side of the cam. Fig. 7 is drawn in the same way, except that the arc on the working edge is reversed and the half circle is divided into 18 divisions, which are then used in the manner described for Fig. 3.

Fig. 9 shows a positive-motion cam which moves the rod *B* to the right or left (according to the direction in which the cam is revolved) during one quarter of a revolution, the rod then remaining stationary during the next quarter of a revolution, and during the third quarter it will be moved back to its original position and there remain stationary during the last quarter. The motion is harmonic and, as will be readily seen, the cam must be made about right or it will either not work or have lost motion. It is not, however, difficult to lay out if care be taken to get everything accurate.

First divide the two opposite quarters into an equal number of divisions, in this case 8 (it is really only necessary to di-

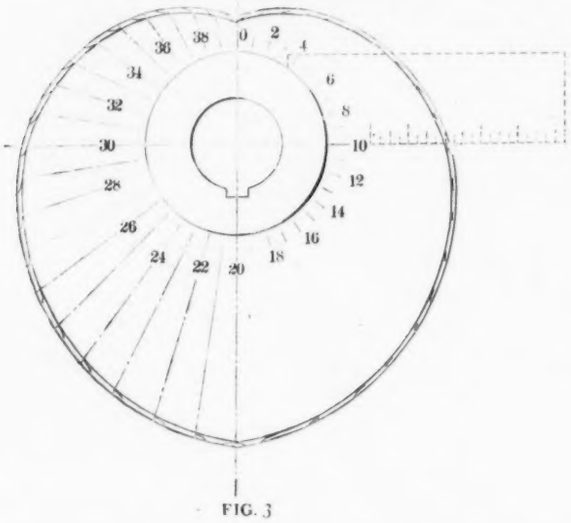


FIG. 3

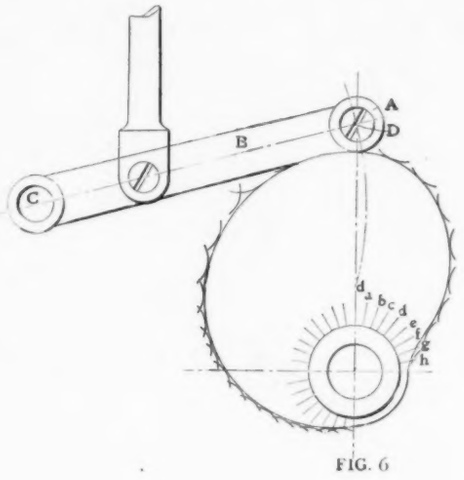


FIG. 6

FIG. 4 FIG 5

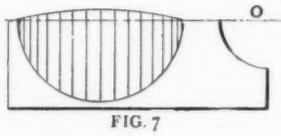


FIG. 7

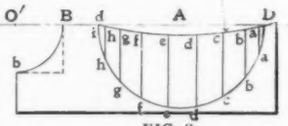


FIG. 8

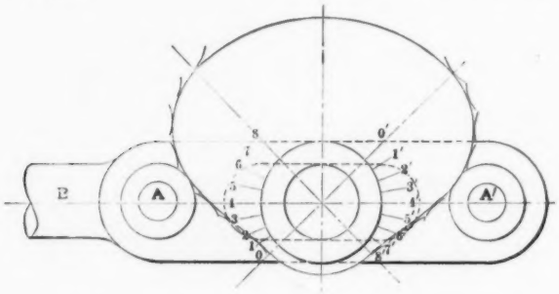


FIG. 9

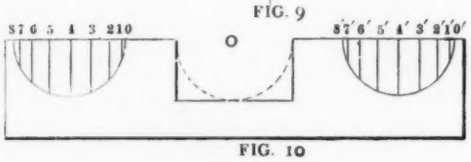


FIG. 10

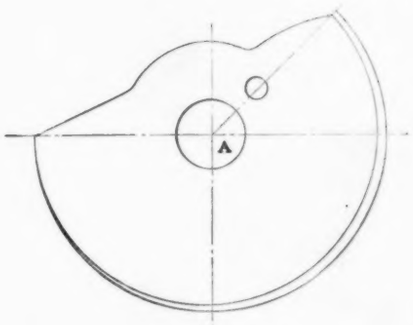


FIG. 11

LAYING OUT CAM CASTINGS.

vide one quarter, but more accurate results will be obtained by dividing both), then make the center carrier shown in Fig. 10. With *O* as a center describe the dotted half circle equal to the diameter of the hub Fig. 9. (The center recess of all the center carriers may of course be cut out square as shown in Fig. 10 or it may be made a half circle.) Point off the distances *O* 4 and *O* 4′ in Fig. 10, equal to the distance *O A* and *O A′* in Fig. 9. The rod *B* is to travel 1½ inches and with 4 and 4′ (Fig. 10) as centers we describe two half circles 1½ inches diameter, divide them into 8 equal parts and project these points to the straight working edge as shown. The method of using this center carrier should now be clear.

Fig. 11 represents the style of cam used on the Brown & Sharpe automatic screw machine. I once had several of these cams to work over as they had become badly worn, and I used the following method to lay them out which I found to be very satisfactory. I found a round plug gage that just fitted the hole *A* and had a ⅛-inch hole in the center of the end. I put the gage in the cam with the end flush with the surface of one side, giving a plane surface with a ⅛-inch hole in the center. I then inserted a short piece of ⅛-inch drill rod in the hole. A very small flexible wire with a loop in one end for the scratch awl was wrapped at the other end around the ⅛-inch rod. After several turns had been made to bring the wire the right length, I put the point of the scratch awl through the loop, drew the wire taut and scribed a line around the outer edge of the cam, allowing the wire to wind or unwind as the case might be around the rod. This gave a true involute curve, just the thing for these cams. A ⅛-inch rod gave too much throw for the cams being worked on and to allow for this I put the rod in the speed lathe and filed down the part the wire was to be wound on until it was the right size. I found that I could lay out a cam by this method in less time than it would take to scribe the curve by the old method. This method is satisfactory only when the curve is long and the throw small.

Consul-General W. A. Rublee, of Vienna, reports that after years of experimenting, a Hungarian chemist has succeeded in producing optical lenses, which are composed of an outer case of glass, which is hermetically sealed, and between these glasses is a fluid having practically the same co-efficient of thermal expansion as the glass, and otherwise adapted perfectly to the purpose of a lens. It is stated that large lenses made in this way can be produced much more cheaply and more quickly than where made of solid glass, and that the invention is looked upon as an important one.

Apparatus for Determining Hardness by the Brinell Ball Test.

We referred at page 1053, Volume 24 (1901), to the Brinell ball test for the hardness of metals. It was in 1900 that J. A. Brinell, then chief engineer and technical manager of the Fagersta Iron and Steel Works in Sweden, first made known this new method, which he had devised, by submitting to the Association of Swedish Technicians in Stockholm a competitive essay on the subject, and was awarded a gold medal by the association. The exhibit at the Paris Exhibition of 1900 has already been referred to in our pages. Since that time the practical value of the method has been further demonstrated by comprehensive tests by distinguished scientists in different countries.

The essential principle of the Brinell method consists in forcing a hardened

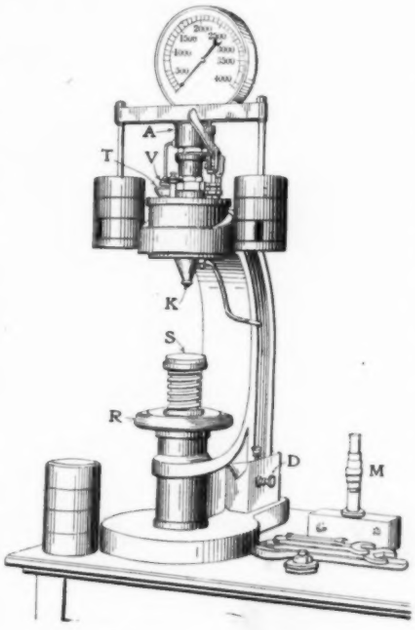


FIG. 1. MACHINE FOR DETERMINING HARDNESS BY THE BRINELL BALL TEST.

steel ball partly into the test sample so as to effect a slight impression, the dimensions of which will then serve as a basis for ascertaining the property of hardness. A unit of hardness, or, as they call it, a "hardness numeral," is employed, the expression of hardness being obtained by dividing the amount of pressure made use of (in kilograms) by the area of the impression (in square millimeters). It is, of course, necessary in making use of a standard unit of hardness that the size of the ball and the amount of pressure used shall be a standard; for the former a ball of 10 millimeters diameter has been adopted, and for the latter a pressure of 3000 kilograms in the case of iron and steel, while in other metals and softer material in general, 500 kilograms pressure is used. It is then only necessary after applying the standard pressure and measuring the diameter of the impression by means of a suitable microscope to look up the corresponding hardness numeral in a table prepared for this purpose (copies of which may be obtained from the Aktiebolaget Alpha).

Mr. Brinell points out in his essay that this method offers a ready and convenient means of ascertaining the ultimate stress in iron and steel, a ratio between the hardness numeral and the stress being determined by experiment. G. Dillner, the director of the testing office of the Royal Technical High School at Stockholm, undertook a series of experiments for this purpose upon a variety of specimens of annealed material obtained from different iron and steel works, and established the following coefficients:

Hardness numerals below 175,
Impression effected transversely to the rolling direction 0.362
Impression effected in rolling direction 0.354
Hardness numerals above 175,
Impression effected transversely to the rolling direction 0.344
Impression effected in rolling direction 0.324

To illustrate the use of the table and coefficients by an example, suppose that upon testing an annealed steel bar with the ball test applied to one of the side surfaces that the diameter of the impression had proved to be 4.6 millimeters; we look in the table for a diameter of 4.6, and in the column headed pressure 3000 kilograms, we find a hardness numeral of 170, which expresses the hardness of this specimen. The proper coefficient taken from the above list will be 0.362, and the ultimate stress will therefore be 0.362 multiplied by 170, equals 61.5 kilograms per square millimeter.

Fig. 1 is a representation of a machine for performing these ball tests, constructed by the Aktiebolaget Alpha, Stockholm, Sweden. The machine consists of a hydrostatic press acting downward, the lower part of the plunger being fitted with a 10-millimeter steel ball *K*, by means of which the impression is to be effected into the surface of the specimen. The specimen is placed upon the support *S*, being vertically adjustable by means of the wheel *R*, while at the same time allowing of its being more or less inclined whenever this is necessary on account of the irregular shape of the object. The whole apparatus is solidly mounted upon a cast-iron stand. The maximum distance between the ball and the support is 200 millimeters, and the depth of gap between the ball and stand is 150 millimeters, though a special stand can be made with a greater gap if desired. The machine is approximately one meter in hight over all and weighs about 130 kilograms net. The pressure is produced by means of a small hand pump, and can be directly read off in kilograms upon a pressure gage es-

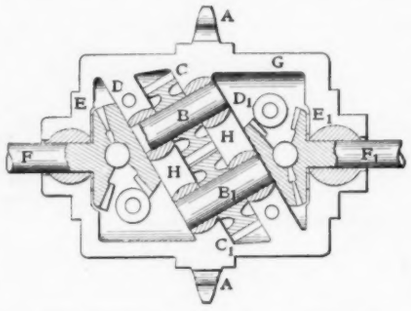
pecially graduated for this purpose. In order to render the motion of the piston quite frictionless no packings are made use of, the necessary tightness being secured by means of careful workmanship in making the piston and the cylinder fit very closely. Any small quantities of fluid escaping are collected in a receptacle D at the base of the stand, from which they are now and then poured back through the funnel T into the oil reservoir of the press.

With the purpose of checking the accuracy of the pressure gage, a special device has been provided, which shows when the desired pressure has been attained, and at the same time prevents any excess of pressure. This consists of a small cylinder A directly communicating with the press cylinder, and also containing a frictionless piston, which is to be loaded with weights corresponding to the amount of pressure required, and when this pressure has been attained the piston will be pushed upward by the pressure.

The following is the method pursued in making the ball test:

The test specimen must be polished on the spot where the impression is to be made, and it is then placed upon the support S, which is adjusted by means of the hand wheel R so as to come into contact with the ball K. The valve V between the press cylinder and the oil cistern being closed, a few rather slow strokes with the hand pump will apply the pressure, which is indicated by the pressure gage and also by the movements of the little piston already referred to. In testing specimens of iron and steel the pressure is to be maintained for about 15 seconds, but in the case of softer material for about half a minute; and at the end of this time the pressure is relieved and the ball withdrawn by opening the valve V, when a spring within the cylinder will force the piston back and return the liquid to the cistern. A special microscope M, giving results exact to 1/20 millimeter, is then used to measure the diameter of the impression, and the corresponding hardness numeral is found in the table.

The diagrams, Figs. 2 and 3 are samples of the results obtained by Mr. Dillner upon making comparative tests upon annealed material by means of the Brinell ball-test apparatus, and by means of a Riehlé tensile machine; the abscissas represent the percentage of carbon in the material (from 0.1 to 1.0 per cent.), and the ordinates represent the breaking stress in kilograms per square millimeter. It will be noticed how closely the results obtained by the tensile testing machine corroborate the results of the ball tests, especially for the materials having the smaller proportion of carbon, that is below 0.5 per cent., which is the class of material mostly used in construction.



A DIFFERENTIAL GEAR FOR AUTOMOBILES.

Of course it would be necessary to employ other coefficients for material which has been submitted to other treatment, such as cold working, or some particular thermal treatment, or in the case of some special steel.

This method has the advantage of being very readily applied and not requiring the preparation of special test pieces, and should be very useful in ascertaining the effects of annealing and hardening of various quenching liquids, and the influence of the temperature of such liquids on hardening results, and also, in making iron and steel, in determining the effect of different proportions of carbon, and in determining the quality of pieces of metal in cases where it is impossible to obtain regular test pieces. Other applications will suggest themselves.

An Odd Balance Gear for Motor Vehicles.

The automobile has been an immense stimulus to inventive talent. As in the early days of bicycle construction, many details are brought out whose chief merit is novelty, and whose demerits are many. The gear in the cut is of interest as a mechanical oddity, though it has some shortcomings as a differential for motor vehicles.

F and F_1 are the two parts of the axle which drive the wheels of the vehicle; E and E_1 are bevel gears attached to their inner ends; G is the gear case with the sprockets A for the driving chain on its outside; H and H are two parallel diagonal bars extending across the inside of the gear case and integral with the latter, and supporting bearings for the short shafts B and B_1 carrying on their ends the bevel gears D and D_1 respectively, meshing with the bevels E and E_1 before-mentioned; on the central portions of the short shafts are mounted the spur gears C and C_1 meshing with one another. The bevel wheels are all of the same size, and the spur gears are equal to one another. The action of the gearing as a whole is, of course, the same as that of automobile differentials in general. It is not necessary here to trace through the movements of the parts as this will be evident by a very brief study of the illustration. When running straight ahead the whole business, from the sprocket wheel A to the divided axle F F_1, turns as one solid mass. If A be held stationary, and F rotated clockwise, F_1 will rotate counterclockwise with an equal velocity, as with other differentials.

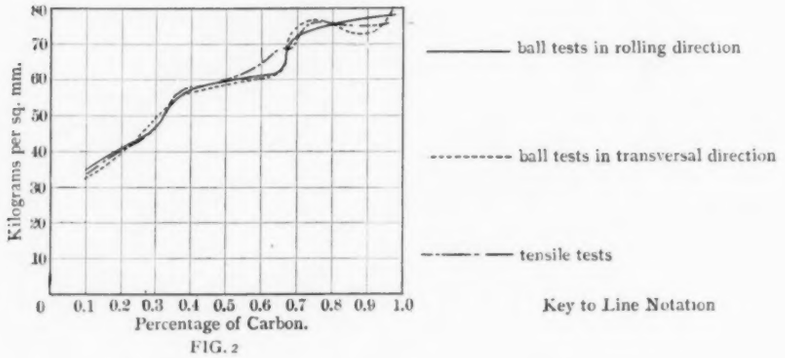


FIG. 2

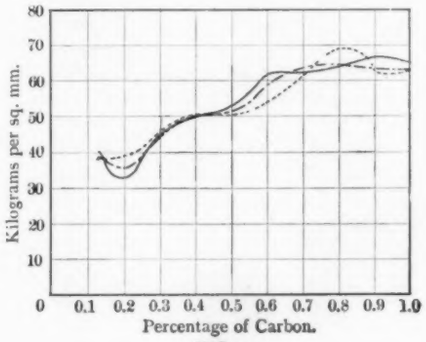


FIG. 3

DIAGRAMS OF PARALLEL TESTS OF HARDNESS AND TENSILE STRENGTH.

The Germans are going in for increased potential in direct-current traction. A 1000-volt direct-current railway is being built between Cologne and Bonn, Germany, 17.6 miles. Instead of a third rail they will use two overhead trolley wires in parallel, the tracks as usual forming the negative side of the circuit.

The Polar Planimeter and Some of Its Special Applications—I.

BY J. Y. WHEATLEY.

While the polar planimeter as an aid in the solution of engineering problems is probably one of the best known and most frequently used of the instruments devised for the mechanical performance of the operations of applied mathematics, it is equally true that even those whose use of the instrument is most frequent have comparatively little knowledge of the extent to which it can be employed in the solution of the problems so constantly occurring in all branches of engineering work.

The generally accepted idea of the planimeter is that it is an instrument whose capacity is limited to the measurement of a plane area or to the determining of the average hight of an indicator diagram.

While the planimeter performs these two operations with a facility and degree of accuracy unattainable by any other means, it will be found that the principle which enables it to do so is, when properly applied, capable of extending the application of the instrument to an almost unlimited number of other engineering and scientific problems which it will solve with an accuracy and facility quite equal to that shown in the two specified.

It is not the purpose of the present article to enter into any mathematical demonstration or discussion of the theory of the planimeter, for however interesting such a discussion might prove, a clear understanding of the general principle of the instrument is all that is required for its intelligent use.

To explain this general principle and understand its application in the following examples of the use of the planimeter, a brief description of the construction and operation of the instrument is, however, necessary.

DESCRIPTION OF THE INSTRUMENT.

The form of instrument shown in Fig. 1, is the Coradi Compensating Planimeter and is a typical form of the polar planimeter with the addition of an ability to compensate certain errors inherent in the usual instrument of this form.

It will be seen from the figure that the instrument consists of two separable arms, each about eight inches long, and made of square german-silver tubing.

The pole arm P has at one end the pole weight b having on its under side a projecting pin point which can be pressed into the drawing paper, and thus hold the pole securely in any desired position on the drawing. The other end of the pole arm has a ball which fits into a socket or receptacle in the carriage at D.

The tracer arm A has at one end the tracing needle f with its adjustable rest s, and has engraved upon its upper side a scale of half millimeters, with its zero at the tracer f. This tracer arm slides through sleeves on the frame or carriage on which is the vernier n; by this means the carriage can be moved along the arm A and the zero line of the vernier can be brought to any desired division of the scale and fastened there by means of the set screws d and d'.

The integrating wheel L is divided on its circumference into one hundred equal parts, and each part is subdivided into ten other equal parts by means of the vernier c. As the horizontal wheel simply records the number of whole revolutions of the wheel L, the reading of the two wheels taken together will give the total number of whole revolutions and the tenths, hundredths, and thousandths of a revolution of the integrating wheel resulting from the tracing of any given figure. In some operations this reading is considered as being the number of vernier units recorded for the figure, a vernier unit being the unit of graduation of the integrating wheel.

As the number of vernier units recorded for any figure is proportional to the area of that figure it is evident that for any given setting we can assign such a numerical value to a single vernier unit that the number of vernier units recorded for any given figure when multiplied by this assigned value of one vernier unit will give the area of the figure traced—this, assigned value being termed the *relative vernier unit*. When possible the relative vernier unit should be made a simple number as 0.01, 0.1, 1.0, 2.0, etc., so as to make the final multiplication a mental one. It should also be so chosen that the reading for the actual area taken as a unit (in our case 15.5 square inches) shall come within the limits of our instrument.

METHOD OF MEASUREMENT.

The operating of the planimeter in the measurement of a plane area is very simple. Let us suppose that we desire to measure the area in square inches of a plane figure drawn to its natural scale. Looking in the table furnished by the maker with the instrument we are to use, we find that the *setting* given for the scale 1 inch equals 1 inch is say 212.6, and that the value given under the heading *vernier unit* for this scale is 0.01. This simply means that each vernier unit recorded by the wheel for tracing a given figure with the setting 212.6 represents an actual area of 0.01 of a square inch of the area traced.

Loosening the binding screws of the carriage we slide the tracer arm through the sleeves until the zero line of the vernier n is opposite that point of the graduated scale indicated by 212.6 and fasten the carriage. The pole b being placed at some point outside the figure, but in such a position that every point on the periphery of the figure can be reached by the tracer without changing the position of the pole, a point on the periphery is selected as the point of beginning and the tracer brought to this point.

After taking the reading of the wheels we then trace the periphery of the figure with the tracer, the tracing being always clockwise in direction, and having completed the circuit we arrive at the point of beginning and again take the reading of the wheels. Let us suppose that in this case the first reading was say 4432, and the reading after tracing the figure was say 6584. It is evident that the number of vernier units due to tracing the given figure is $6584 - 4432 = 2152$, which is called the *reading for the given area*.

We have seen from the table that for this scale and setting the area represented by each vernier unit recorded is 0.01 of a square inch and hence the area in square inches represented by 2152 vernier units is $0.01 \times 2152 = 21.52$ square inches, which is the area sought.

The method of using the planimeter just described is exactly the same for the measurement of all areas and does not require further explanation. The accuracy of any measurement can be easily checked by tracing the figure backward after having arrived at the point of beginning with the forward tracing. If the tracing was accurately done the final reading after the backward tracing should be the same as the first. When especially accurate results are desired, they can easily be obtained by the method of repetitions—tracing the figure several times continuously and dividing the reading by the number of times the figure was traced.

Before using the planimeter for any measurement its adjustment and condition should be tested by tracing with the given setting one of the known areas furnished by the test plate. Any error in either the value given for the setting or due to the instrument itself will then be at once discovered and can be rectified before beginning the measurement.

RELATION OF READING TO SETTING FOR UNIT AREAS.

In the example given above, the area of the figure measured was given in square inches of actual area. If the figures had been drawn to any other than a full-size scale or had we desired its area in some other area unit such as acres, for example, we should have had to calculate the number of acres represented by one square inch of the figure drawn to the given scale, and then multiplied the value thus obtained by the number of square inches contained in the figure.

If, however, we can establish a relation between the adjustable parts of the planimeter so that we can cause the instrument to record *any* number of vernier units de-

sired while tracing one square inch of actual area, it is evident that we can adjust the planimeter so that its reading for *any* given figure of *unknown* area and drawn to *any* given scale will be the *area* of that figure expressed in terms of *any* unit of area desired.

It is this ability of the polar planimeter to record any number of vernier units desired for tracing a given unit of actual area which gives the instrument its wide range of application to engineering and scientific calculations.

By trial it will be at once evident that for any given constant area the number of vernier units recorded by the integrating wheel is proportional to the length of tracing arm of the planimeter when tracing that area. This ratio is slightly different for different instruments, but is easily determined for any given planimeter in the following manner:

What may be termed the general principle of the polar planimeter can be stated as being that the *area of any plane figure whose periphery has been traced is equal to the area of a rectangle whose base is equal to the length of the tracer arm, and whose hight is equal to the distance rolled over by the integrating wheel during that tracing*

Stated algebraically this becomes

$$A = (c \times r) \times t \qquad (1)$$

in which

A = area of figure traced.
c = circumference of integrating wheel.
r = no. of revolutions of integrating wheel.
t = length of tracer arm.

From which

$$c = \frac{A}{r \times t} \qquad (2)$$

$$t = \frac{A}{c \times r} \qquad (3)$$

In the above equations all of the quantities are variable except c, which is a constant for any given instrument, and when c is determined, the relation between the length of the tracer arm t and the value of $(c \times r)$ for any area A can be at once found by substitution in equations (2) and (3).

The value c, which is the length of the circumference of the integrating wheel in millimeters, is different for different instruments even of the same form and make. It is customary for the maker to mark its value as near to 60 millimeters as possible, but it usually varies from that value by a small amount. Its correct value is not usually given by the maker, although in some cases it is furnished with the instrument at an extra cost; but it is easily found for any particular planimeter in the following way:

Looking in the table furnished by the maker, which is usually found pasted on the inside of the case, we take from it the value given for the scale 1 inch = 1 inch under the heading Setting, and that given under the heading Vernier Units for the same scale—these values we will suppose are 339.4 and 0.01 respectively for our particular planimeter.

In the case with each instrument the maker furnishes a test plate or strip by means of which a known area can be accurately traced with the tracer. In this case the test strip furnished an accurate area of 10,000 square millimeters or its equal, 15.5 square inches.

Tracing this test area with the planimeter adjusted to the given setting 339.4, the reading for this area was found to be 968.75 vernier units.

We have already stated that the scale engraved on the tracer arm is a scale of half millimeters, and hence, since the setting is given in ½ millimeters, the value of t, which is the actual length of the tracer arm, is $\frac{339.4}{2} = 169.7$ millimeters. Substituting these values in equation (2) we have

$$c = \frac{A}{r \times t} = \frac{10000}{968.75 \times 169\ 7} = 60.8.9\ mm. \qquad (4)$$

Having found the length of the circumference of the integrating wheel in the manner just described, we are able to find by equation (3) what length of tracer arm expressed in millimeters, or its equal, what setting expressed in ½ millimeters, we must have in order that the integrating wheel shall record a desired number of vernier units for tracing a given unit of actual area A.

The unit area selected would ordinarily be 1 square inch, but since our test strip furnishes us a means of very quickly and accurately tracing an accurately known area of 10,000 square millimeters = 15.5 square inches, which can also be used as a check on the accuracy of the calculation, we shall use this as our unit of area.

An additional reason for the choice of this area for our value of A is that in checking the accuracy of any calculation for the value of any setting by tracing the test-strip area with the calculated setting, any error in the value of the setting would appear 15.5 greater by using the test-strip area than if the area were 1 square inch, and hence we can adjust our planimeter with proportionately greater accuracy for any operation, since it also serves to eliminate any constant instrument error that may exist.

If now we substitute in equation (3) the constant values for A and c for our particular instrument, we have

$$t = \frac{A}{c \times r} = \frac{10000}{60\ 829 \times r} = \frac{164.39}{r} \qquad (5)$$

Equation (5) shows that to find what value of t is required to cause the planimeter to give a desired reading r for tracing an area of 10,000 square millimeters or 15.5 square inches, we simply have to divide the constant 164.39 by the desired number of revolutions of the wheel, and the quotient will be the length sought. This quotent multiplied by 2 will of course give the setting desired.

To illustrate the applications of these equations let us suppose that we have a map drawn to a scale of 1 inch equal 60 feet, and we desire to find its area in acres.

Since 1 inch equals 60 feet, then 1 square inch equals 60^2 equal 3600 square feet, and since the area of our test plate is 15.5 square inches, this area will represent an area of $3600 \times 15.5 = 55{,}800$ square feet.

Since 1 acre equals 43,560 square feet, the test-plate area will represent $55{,}800 \div 43{,}560 = 1.2808$ acres.

To obtain the length of tracer arm or the setting required to cause the planimeter to record 1280.8 vernier units for tracing the test-plate area we substitute our desired value of r or 1.2808 in equation (5) which gives

$$t = \frac{164.39}{r} = \frac{164\ 39}{1\ 2808} = 128.35\ mm.$$

and

$$s = (.28\ 35) \ 2 = 256\ 7\tfrac{1}{2}\ mm.$$

Having adjusted the planimeter to the setting 256.7 we trace the map and the reading obtained multiplied by .001 will be the desired area in acres.

WEIGHT OF METAL BEAMS.

One of the most important calculations of the structural engineer is the determination of the area and weight per linear foot of simple and built-up metal beams, and similar sections.

While these values for regular or standard shapes are usually given in tables issued by the manufacturers, other methods for obtaining them must be employed when the sections are irregular and unsymmetrical, and of these the results obtained by the use of the planimeter are by far the most accurate.

To illustrate the use of the planimeter in these calculations let it be required to find the area and weight per foot of a beam of any section whatever—the beam to be of wrought iron and the section drawn to a linear scale of say ½ inch equals 1 inch.

Since ½ inch on the drawing equals 1 inch actual length, 1 square inch of actual area will represent 4 square inches of area, and our test-plate area of 15.5 square inches will represent $4 \times 15.5 = 62$ square inches. Since 1 cubic inch of wrought iron weighs 0.2777 pound, then 62 cubic inches would weigh $0.2777 \times 62 = 17.217$ pounds, and a beam of this section 1 foot long would weigh $17.217 \times 12.0 = 17.217$ pounds. Factoring this result in the manner previously explained, we can make $r = 1033.04$ and the value of the vernier unit 0.2, since $1033.04 \times .02 = 20.6608$.

Substituting in equation (5) we get $r = 1033.04$.

$$Setting = \frac{328\ 795}{1.03304} = 318\ 26.$$

Adjusting the planimeter to this setting we trace the given section and the reading recorded for that section multiplied by 0.2 will give the weight in pounds per linear foot of the beam.

Should the beam be of any other mater-

ial than wrought iron its weight per linear foot would be found by multiplying the weight per foot of a wrought-iron beam of that section found in the manner just described by the gage point for the metal of which the given beam was made.

The gage point of any metal is simply the weight of any unit of volume such as a cubic foot of that metal compared with the weight of a cubic foot of wrought iron taken as unity.

The gage points of some of the most commonly used metals are as follows: Wrought iron, 1.00; cast iron, 0.93; cast steel, 1.02; copper, 1.15; brass, 1.09; lead, 1.47; zinc, 0.92.

It is evident that the weight per foot of a beam of any section could be found by finding the area of the given sections in square inches, and multiplying this area by the given weight of 1 cubic inch of wrought iron and they by 12.

The method explained is, however, much to be preferred, for having once found the values of the *setting* and its corresponding *vernier unit* for *all* of the ordinary scales to which these sections are drawn, we can make a table giving these values for the different scales, and when we wish to find the weight per foot of any given section we have only to adjust the planimeter to the setting given in the table for the given scale and, having traced the section, to multiply the resulting reading by the value of the vernier unit, thus avoiding any mathematical calculation except the last multiplication.

EXAMPLE OF RESERVOIR CALCULATIONS.

It will take but little thought to realize the enormous importance and value which the principle expressed by equation (3) gives to the polar planimeter, and the almost limitless range of application of the instrument to all forms of engineering computation due to its possession of this principle. By substituting proper values of r in equation (4) and adjusting the planimeter to the resulting value of the *setting* we are able in most cases by the simple tracing of an area to solve a problem which, without the aid of the planimeter, could only be obtained by a series of long and tedious mathematical calculations and with an accuracy impossible by any other method.

While the saving in time and effort due to the use of the planimeter in engineering calculations is almost incredibly great, it can be very greatly increased by the preparation of the set of tables previously mentioned giving the *setting* and corresponding *vernier unit* for these problems of most frequent occurrence. It is evident that these values vary not only for different problems but also for the linear and area scales to which the area to be measured is drawn and to the area unit in terms of which we desire the unknown area to be expressed.

With a table prepared as described we are in many cases able to solve a problem in a very small fraction of the time required by the ordinary methods of computation.

To illustrate this, and at the same time to show the range of problem to which the planimeter can be applied, we will describe its use in the following problem—assuming that we are in possession of tables prepared in the manner already described.

Let us suppose that we are called upon to make a report and estimate of cost on a proposed dam and reservoir, at the site of which Fig. 2 is a contour map drawn to a scale of 1 inch = 20 feet, the vertical contour interval being 10 feet, with the datum plane taken at the surface of the water in the creek at the proposed site for the dam.

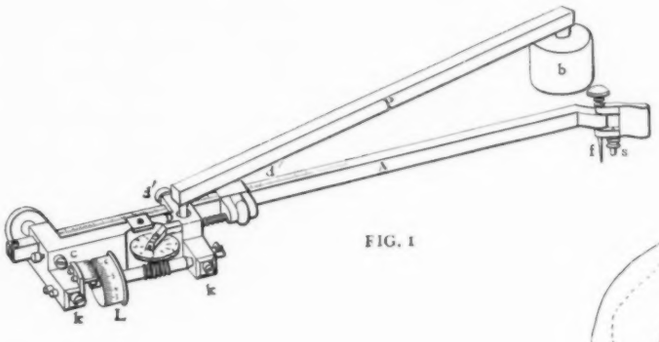


FIG. 1

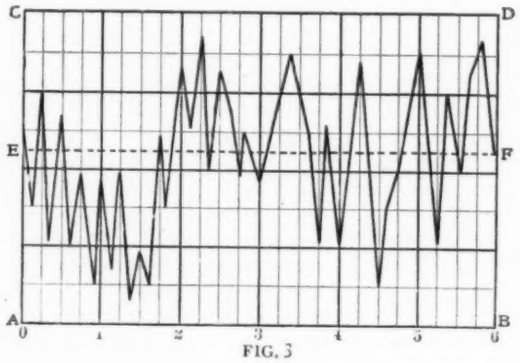


FIG. 3

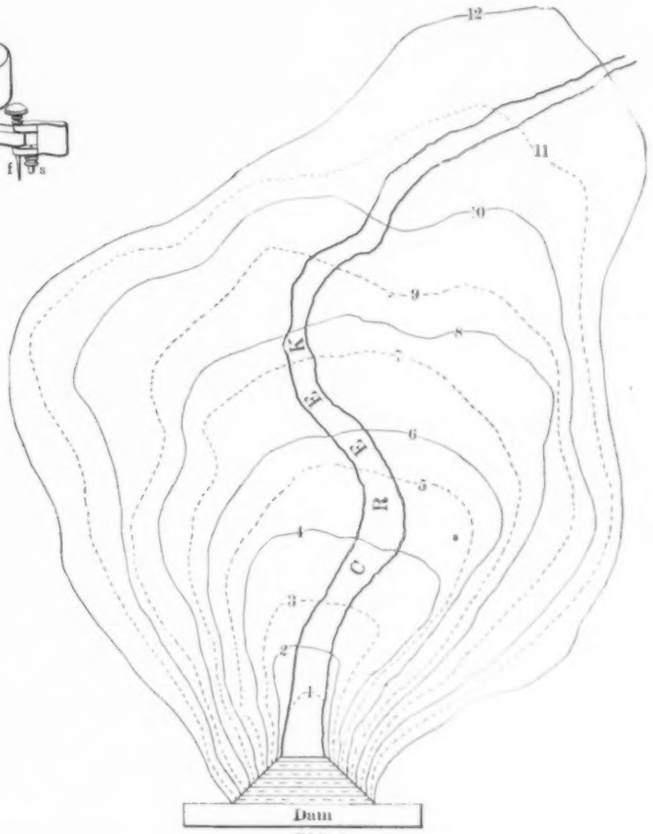


FIG. 2

The prismodial formula for the volume of water in U. S. gallons reduced for the given contour interval and for the given scale is: (A being the area inclosed by a numbered contour):

$$V = 1994.8\ (\text{sum even } A\text{'s} + 2\ \text{sum odd } A\text{'s} - \tfrac{1}{2}\ \text{sum end } A\text{'s}).$$

Looking in our table of Contents of Solids for the scale 1 inch = 20 feet, we find the value of the setting and vernier units to be 319.6 and 30 respectively. Adjusting the planimeter to the setting 319.6 we trace the contour marked 1 and that marked 12 and, adding the two readings, we set down their half sum. We then trace all of the *even* numbered contours

continuously, letting the instrument do the adding, and set down the final reading. Similarly we trace all of the *odd* numbered contours and set down the resulting reading multiplied by 2. We then add the reading due to the even contours to *twice* the reading due to the odd contours and subtract the half sum of the reading due to tracing the first and last contours, the final value thus obtained multiplied by 30 will be the quantity of water in the reservoir when the reservoir is filled to the 12-foot level, its total capacity.

Looking in our table of Map and Survey Scales we find that for the scale of 1 inch = 20 feet the setting and vernier units for areas in acres are 277.1 and .00012 respectively. Adjusting the instrument to the setting 277.1 we trace the contour line 12; the reading obtained multiplied by .00012 will be the area included within the 12-ft. contour, or the number of acres of land covered by water when the reservoir is filled to its full capacity.

Knowing that our dam should be 12 feet high above the creek water, and having from the contour line at the dam site the data for a profile of the longitudinal center line of the dam, we can at once draw to any scale the cross section of the dam at different points along its length. Looking in our table of Construction Scales we find the setting and vernier unit for the scale to which we have sketched the probable cross sections of the dam, and tracing the cross sections with this setting, the reading multiplied by the vernier unit will give the amount of masonry for that cross section of the dam in cubic yards per linear foot.

Tracing the longitudinal profile of the dam included between the probable bottom of the foundation and the ground surface with the same setting and vernier unit will give us, when multiplied by the width of foundation, the number of cubic yards of earth excavation required for the dam.

With the data thus obtained the desired approximate estimate can easily be made. It has been repeatedly demonstrated by experience that the accuracy of the measurement of any figure is quite equal to the accuracy of the drawing, so that the degree of accuracy of the results obtained in the manner described is entirely dependent on the care taken in making the drawings and in tracing their lines.

MEASUREMENT OF INDICATOR AND SIMILAR DIAGRAMS.

I have stated the general principle of the polar planimeter as being that "the area of any plane figure whose periphery has been traced by the tracer is equal to the area of a rectangle whose base is equal to the length of the tracer arm, and whose altitude is equal to the distance rolled over by the integrating wheel during the tracing."

This principle enables the planimeter to mechanically solve a large and important number of problems, in which the accurate determination of the average value of a variable quantity is required for their solution.

Referring to the algebraic expression of this principle as given by equation (1), we can at once see the method of its practical application.

Equation (1) is

$$A = (c \times r) \times t$$

in which

A = Area of equivalent rectangle = Area of given figure.

t = Base of equivalent rectangle = Length of tracer arm.

$c \times r$ = Altitude of rectangle = Circumference of wheel multiplied by number of revolutions = Distance rolled over by wheel while tracing figure.

The best illustration of the practical application of this principle is perhaps given by the use of the polar planimeter in finding the average hight of an indicator diagram.

It is evident from equation (1) that since the area of an indicator or similar diagram is equal to the length of its base multiplied by its average or mean hight, if we make the length of the tracer arm t equal to the length of the base and trace the periphery of the diagram, the distance rolled over by the wheel, or the value of $(c \times r)$, must be equal to the average hight required.

Hence to find the average hight of any such diagram we have simply to make the length of tracer arm equal to the length of base of the diagram and then trace the periphery of the diagram—the length of the circumference of the integrating wheel multiplied by the number of revolutions of the wheel is then the average hight desired.

Thus in Fig. 3 to find the mean hight BF of the diagram DC we make the distance fD (Fig. 1), or the distance between the tracing needle f and the center of the ball joint at D (which is always taken as the length of tracer arm) equal to AB and trace the diagram. The circumference of the wheel multiplied by the number of whole revolutions and decimals of a revolution will then be the distance $BF = AE$ or the average hight of the diagram in millimeters.

In this or any similar operation the length of base AB need not be known, as the length of the tracer arm can be made equal to it with the planimeter described, by placing the tracing needle at B and then moving the carriage along the tracer arm until the point A is seen directly under a small hole in the bottom of the receptacle at L.

It will not be necessary to even enumerate the very large class of problems to whose solution this averaging principle of the planimeter is applicable. They include the finding of the average value of the records of all forms of self-registering instruments such as barometric, thermometric, tide and numerous other diagrams and give this value with an accuracy impossible by any other means.

When we consider the large amounts, either given as bonus or exacted as penalty by the United States authorities as a result of their tests of newly constructed vessels and equipment, and remember that many of their most important results are dependent on the accuracy of the planimeter, we can gain some conception of its value in this form of computation. In many cases the results obtained by any other known method would be only an approximation and often of such questionable accuracy as to preclude their use.

The Norton Company and Alundum Grinding Wheels.

We learn that the Norton Emery Wheel Company, of Worcester, Mass., has changed its name to the Norton Company, the reason for the change being that the grinding wheels made by this concern are no longer made of emery, this natural abrasive having been completely displaced in their wheels by the artificial abrasive "alundum" which the company manufactures in electric furnaces at Niagara Falls.

This abrasive, which is harder than any known substance except the diamond, and which, because of its superior cutting qualities has caused the abandonment of emery in the Norton manufactures, is made by taking the purest amorphous oxide of aluminum found in nature, known as the mineral bauxite, purifying it and melting it in the electric furnace in a large, homogeneous bath. Upon cooling, the molten fluid solidifies and crystallizes in solid masses of alundum of great purity and of uniform character throughout. Bauxite, the raw material from which alundum is made, was discovered at Baux, France, from which it derives its name, but purer forms are now attainable in our own country. It is interesting to note that this ore is also the chief source of the metal aluminum. The temperature at which the furnace charge melts into a homogeneous liquid mass, is above the limit at which temperatures are measured by any means known to science, and is variously estimated at between 6,000 and 7,000 degrees Fahrenheit.

In the manufacture of "vitrified" wheels, which the Norton Company was one of the first to engage in, the abrasive materials are mixed with various clays and other substances, and then after being formed, are placed in kilns, or ovens, and subjected to high temperatures, in some cases nearly 3000 degrees Fahrenheit. Only the purest abrasives will stand this severe heat successfully, and it has been found that there is no abrasive material which works to better advantage, under these conditions, than alundum.

The Commerce of the Philippines in 1905 as Compared with 1904.

Two of the most noteworthy features in connection with the commerce of the Philippine Islands during the past calendar year are that there is a balance of trade in favor of the Islands for the first time since the American occupation, and that the United States is fast forging to the front rank as a contributor to the import trade. The total imports for the past year amounted to $30,050,555 as compared with $29,577,731 in 1904; and the exports to $33,454,774 as compared with $29,149,500.

In the iron- and steel-trade total during the past five years the most conspicuous feature is the increase of half a million dollars in 1905, when the trade reached a value of almost three million dollars. This trade is participated in by many countries, with the United States, United Kingdom, and Germany as the leading sources of supply.

The demand for steam railway cars in a country such as this is, of necessity, greatly limited by the surroundings, and the demand is nearly nominal, yet there has been an increase from $1800 in 1904 to $42,233 in 1905. In cars for electric and other railways there has been an increase from $8041 to $162,590; in this line the United Kingdom leads with a value of $83,961, the United States following with $33,637.

The imports of pig iron in 1904 were valued at $11,330, in 1905 at $14,253, all from the United Kingdom. Bar-iron imports in 1903 were valued at $60,237, in 1904 at $62,326, and in 1905 at $68,103. In each instance the United Kingdom was the leading source of supply with Belgium second.

There has been an increase in steel rails for railways, from 4699 tons at $132,507 to 7499 tons at $193,300.

Under the heading of iron sheets and plates there has been a material increase from $188,223 to $300,844; here again the United Kingdom is in the lead with Belgium second, the United States coming third with a very poor and diminishing share of the trade. Steel plates also show a material increase from $11,508 in 1904 to $20,182 in 1905; here again the United States shows diminishing exports while the United Kingdom shows increasing ones.

Among other manufactures of iron and steel, imports of structural materials have shown a rapid increase in recent years. It was not until 1904 that the United States took any material part in this market; up to that time the United Kingdom had been the leading contributor, but last year the United States' share exceeded the British and constituted more than one-half of the total amount.

Imports of wire and wire cables, though of less value, follow the same general lines of increase shown in structural materials.

The agricultural implement trade of 1905 amounts to ninety thousand dollars, of which the leading items are plows and cultivators.

In the nail trade of the island, approximately $60,000 annually, the United Kingdom and Germany are also active participants, but the lead has been maintained during the past two years by the United States, with shipments valued at about $25,000, while in the imports of pipes and fittings, amounting to about $75,000 in 1905 American trade represents far the greater part, as it does in previous years.

In the following items during the past year the United States has stood in the lead with the amounts named, viz: Electrical machinery, $230,086, out of a total of $235,330; pumps and pump machinery, $17,256, out of a total of $21,798; locomotives, $17,143 out of $30,553; stationary engines, $57,732 out of $77,352; boilers and parts of engines, $40,986 out of $80,451; typewriting machines, $29,694 out of a total of $30,067; other machinery and apparatus, $145,041 out of $238,678; detached parts, $66,379 out of $103,928; wire, $21,643 out of $37,107; pipes and fittings, $63,722 out of $75,894; safes, $5165 out of $10,449; scales and balances, $10,149 out of $12,384; stoves and ranges, $8832 out of $11,467; all other manufactures of iron and steel, $121,718 out of $340,699.

Phosphor-Bronze Springs.

BY HENRY R. GILSON.

A few years ago it became necessary for me to make use of springs of phosphor-bronze wire, to be worked in salt water. Brass and steel had been tried and found unsuccessful. The constant stretching and compressing of the steel caused all kinds of waterproof coatings to scale off and expose the metal to the action of the salt water, which soon rendered the springs useless. The zinc and copper in the brass led to electrolytic action, and as a consequence these springs proved unsatisfactory. Phosphor-bronze was next tried and found to stand the action of salt water without any appreciable change.

A diligent search through text-books failed to reveal any data for calculating the safe load, deflection, etc., of springs made of this material, and consequently experiments were made upon various sizes of wire up to ¼ inch in diameter.

It was found that by using different constants the formulas given by J. Begtrup in the AMERICAN MACHINIST of Aug. 18, 1892, for the deflection and carrying capacity of helical springs of round steel could be used and gave results which agreed very closely with the actual measured compressions of the springs. The formulas adapted for phosphor-bronze wire such as is manufactured by the Phosphor-Bronze Smelting Company, of Philadelphia, are as follows:

$$W = \frac{7000\, d^3}{D - d}$$

$$F = \frac{8\, P (D - d)^3}{6{,}200{,}000\, d^4}$$

When $W = P$;

$$F = \frac{7\, (D - d)^2}{775\, d}$$

W = carrying capacity in pounds.
d = diameter of wire.
D = outside diameter of coil.
F = deflection in one coil.
P = load in pounds.

I have used and am using these formulas for springs of all diameters, ranging from $d =$ No. 10 B. & S. gage to $d = \frac{5}{8}$ inch and have by tests upon the springs proved them to be accurate within 10 per cent. They apply equally well to tension springs wound closely without initial tension.

Echoes from the Oil Country—Identifying Oil by Means of "Homemade" Apparatus.

It would be impossible for the mechanical world to exist as it does today if it were not for oil. By the word oil I would indicate all of the various grades of lubricants. While a few will object to this statement it will be recognized that oil is one of the common things that can be made from a great variety of substances, and that for many uses it is largely a matter of cost as to which one of a number to use for any given purpose.

Occasionally it comes about that the difference between the lubricants selected makes the difference between success and failure, and this is largely true in gas-engine practice.

The conditions that exist in the cylinder of an internal combustion engine are so different from those found in general practice that when the gas engine sprang into prominence a decade ago there was a striving all along the line to find an oil that would be suitable. While it is true that as soon as the want was made known many dealers and refiners of oils offered to supply goods that would fill every possible need, yet it was very apparent that many of these offerings came very far from it.

I was not selling oil, but from my position in the mechanical world I was where it was necessary for me to have a good one for use, and one that I could recommend to others as being good. A mechanic is not by any training of his trade or by any natural instinct an oil expert, and I did not have any training or education on the subject outside of the information I had picked up from time to time when "out on jobs" at the various oil refineries in this section of the country.

The first oils tried were the ordinary lubricating oils as used in the shop; these

were all products of crude petroleum and because of the unsatisfactory results samples of a gas-engine oil were obtained from one of the refineries. This oil was given to me to test. Soon the samples became numerous, and the results were nearly as numerous as the samples, and it was also found that while an oil from one dealer or maker might keep the same name, it might also have a very confusing way of changing all of its other characteristics. This was particularly provoking when the sample had given promise of good value for the work to be performed. The great trouble was that the conditions were new, and the knowledge as to just what the conditions really were was not at all complete, and so it happened that the refiners were working in the dark; and there is another point that had to be reckoned with. Most refiners were planning to get out of the oil all there was in it, and it would seem that most of them were trying to fill this want by a selection from the oils they already made, and, failing in that, to make a suitable oil by mixing two or more of them together and changing this or that ingredient, as indicated by the good or bad reports of their customers.

I will explain how things worked out in practice. An oil refinery would get out a gas-engine oil and then see some of the firm and tell of its good qualities, and try to get an order for some, or perhaps send in a sample of a few gallons with the request that it be tested. The testing consisted in using it on a new engine and watching very closely the results. The quantity used in a given time, the condition of the surfaces and all such practical points would be noted, and on them depended the report. We will suppose a sample had been sent in and found to be good. By and by along would come a barrel of oil for shop use. After a few days in would come the foreman of the erecting and testing department. "Say! That last barrel of gas-engine oil is something fierce. It smokes and gums, and I have to use a stream of it as big as your finger, and then it is hard to get a smooth cylinder." Of course, with a report like that from a competent man the office has to be informed.

The purchasing agent—he has also other titles and duties in this concern—is told, too. When he hears the report he is indignant.

"What is the matter with you fellows, anyhow? It is not very long ago that you put in a report on that oil and said that it was first class." He has the report at hand to prove his assertion. "Now, when I order some of it you come in here kicking. It's 'what is the matter with you?' instead of 'what is the matter with me?'"

"Are you sure that you got the same oil?"

"Sure of it? Of course I am sure of it. I put the name of the oil on the report as soon as I got it, and if you will look on the barrel that you have now you will find it is the same, and here is my order which calls for 'one barrel of Perfection Gas Engine Oil; this to be exactly the same as sample received from you on—,' etc. It is up to you fellows to make your tests so that you will know what you are doing." And there didn't seem to be any doubt but that it was. The erecting-shop foreman and his men were sure that the barrel of oil was not the same as the sample, but had no way to prove it. I did not think it was of any use to do any arguing about the matter until proof was at hand. After a little thought a cheap hydrometer was obtained at a neighboring drug-store. The cheapest thermometer that could be found that would indicate high temperatures was bought. It was graduated up to 690 degrees. A bottle that would hold about four ounces had a three-eighth hole drilled in the center of the bottom, and a short piece of glass tubing fitted through the center of the cork, and we had a complete set of oil-identifying apparatus. A dairy thermometer was added to the set as a convenience in reading the low temperatures.

Now when a sample of oil came in the gravity was taken and the temperature, by the dairy thermometer, kept at 70 degrees for this and the viscosity test. The viscosity test was made by filling the bottle with the finger closing the hole in the bottom, inverting the bottle and noting the time. On the even minute the finger would uncover the hole and the time would be noted that it took the oil to run out. The number of seconds was the viscosity. To get the flash test, the inside vessel of a small glue pot was filled about half full of the oil, and this was heated over a gas jet and the temperature watched. As soon as a vapor began to rise from the oil, a small lighted splinter would be passed frequently over the surface, and as soon as the vapor flashed the temperature would be noted and recorded as the flash test. A record of each oil tested was kept, and while it was well known that neither the gravity, viscosity, nor flash test as noted was the true one of the oil, yet they served to identify it as well as though they were standard.

The value of the various oils for the purposes intended was judged entirely by their behavior under working conditions, the ordinary procedure being to use a sample on a new engine that was just being started, and to use nothing else until the engine was ready to go out, or until it was shown that the oil was not good for that purpose.

Objection may be raised to the crude standards used, and there is no doubt that they would have been better had they been standard, so that the results could have been compared with the work of the rest of the world; but at the same time it is well to recognize that the poorest of homemade standards are as much better than no standards at all, as the very best standards are better than the homemade ones. The homemade ones can be devised by almost anyone so as to suit his own purposes at a very little expense, while the fine tests are available only where considerable expense is justified, *and where the management can be made to see the necessity of it.* The man who does not work toward devices for helping himself along in his work, but always waits to be led from above, will not be interested in such things.

The tests were made at 70 degrees because it was a temperature that could be gotten without much trouble. It is generally that cool part of the time in summer and the inside temperature is not far from that in winter.

While it is sometimes very desirable to know the cold test of oils used for lubricating machinery, it is not often necessary for purposes of identification, unless very fine distinctions are to be made. In the regular oils on the market there is no use in hair-splitting in testing, as they vary quite a little even when the same thing is aimed at. Anyone who has ever spent any time around an oil refinery does not need to be told that; but it sometimes happens that oils change because of differences in the crude from which they are made, and also because of a changed demand for certain oils made from the crude. There was a time when there was very little demand for anything lighter than lamp oil, and now most of the refineries try to get out all of the gasolene they can, and then do not get enough. It may be the same with the heavier oils. Some certain brand of dynamo oil, for instance, may come into general use, and it hurries the refiner to get enough of it, and this effort in turn interferes with the composition of some of the other oils. These varying conditions make it necessary for the refiner to "cut" his oil differently, as it comes from the still, and often to treat it differently in the still. It is natural for him to handle it so as to get the greatest value out of it, even to the altering of his standards. It is to be understood that all this applies to petroleum in its various forms. I do not know why other oils need to vary as much as they do.

W. Osborne.

At page 787 we published an item regarding some trouble with friction clutches, which trouble had been experienced by the King Machine Tool Company, of Cincinnati, Ohio, and which was overcome by drilling holes in the friction bells to allow the escape of entrapped air. We were under the impression that this clutch was on a machine made by the King Machine Tool Company. We find that this is an error and that the clutch was upon a machine tool which had been purchased of another maker, though of course the difficulty referred to might happen with any well fitted clutch of the same type.

Letters to the Editor.

The Demands of War Influence the Requirements of Peace.

A few years ago the United States Government indicated to the steel manufacturers a paradox. It asked from them an armor that could not be penetrated and a shell that could not be resisted. In response the steel manufacturers produced both within limitations. The armor carried by ships, for structural reasons could not be overweight. The shell that was designed to hit it, if it had the energy, only needed to be of better material, to pass through the armor. The problem was somewhat analogous to that presented to safe makers. They should make a safe into which no burglar could gain admission. In practice they never have made such a safe. If guarded efficiently, as safes are by lights and watchmen, no burglar has time to break into them. But under favorable conditions such as non-interference, any safe is at the mercy of a resolute burglar.

But the problem presented to the Navy was one that concerned both offense and defense and had no reason to take in as factors that which did not belong to the defined and reasonable methods of war. The Navy was concerned in making its ships defensible and, as nearly as possible, invulnerable, and also in making them potentially aggressive to the degree that they could not be resisted. Their ships were to be both the safe and the burglar, and it was necessary that they should be *facile princeps* in both branches.

The history of nickel steel in the Navy begins with the defensive intention. It was known to science that steel practically impenetrable could be made. It had been done in the Krupp and the Armstrong mills as an illustration of an experiment and in so far as it had been attacked in real war, as in Egypt, was successfully resistant. Both mills carried that experiment to its logical conclusion. There is no elementary formula for the making of high-grade steels that has been discovered in this country. Germany and England are the pioneers of progress in that respect. When the United States Government advertised for armor for the first protected cruisers built at Roach's yard, the "Chicago" and "Boston," their specifications were based upon the quality of steel made by Armstrong at Newcastle-upon-Tyne. There was not at that time a mill in this country that could turn out the quality of steel demanded. There was no commercial requirement for it. The best qualities of steel in commerce were structural steels for ordinary uses, and steels for the tools that would cut them. The tool steel was efficient for the demand made upon it for this purpose. But armor plate of the quality asked for was as foreign to our mills as possible. Theoretically they had the formulas of course. In practice they were at best only beginning to experiment.

Several important plants took up the subject, among them the Nicetown, the Bethlehem, and the Carpenter steel works. Other plants entered the competition but with one or two exceptions dropped out for local or political reasons. It was not altogether a matter of technical efficiency. National politics was a strong factor.

It must be admitted that the Government was liberal. It was willing to pay any price in reason for armor, and it was also ready to furnish all the information in its power. The officers of the Navy had made a specialty of the study of armor plate and were well informed as to its methods of manufacture. This knowledge was put at the disposal of the makers, and a trained body of metallurgists was at work pursuing the same aim.

The first contracts were let at the approximate figure of $650 a ton for tested armor plate. There could have been no production of it except in response to the requirements of a splendid and liberal customer, because there was no collateral demand for high-grade steels in commerce. The first plants were expensive almost to the prohibitive limit, and they were in a measure experimental, but in all these stages they marked a definite and permanent advance, and when the first battle ships were laid down, the "Indiana," "Texas," the first "Maine," the "Oregon," the first-class armored cruisers "Brooklyn" and "New York" and the second-class armored cruisers "Minneapolis" and "Columbia," their armor was ready for them at the mills.

But it furnished only the defensive quality. The development of the making of the projectiles and the gun that threw them was as serious a problem, and although the lines upon which success would be attained were known, the road that led to it was marked by many obstacles. Unlike the armor and shell, the gun had a history to refer to. It was the development reached by four hundred years of almost continuous and progressive experiment. But in its later stages the gun was such a radical departure as to be almost a new invention. The rifled big gun was practically unknown until the period of the civil war. The Navy of 1860-1864 fought most of its battles with eight- and nine-inch smooth-bore round-shell guns. A few rifled guns were mounted, usually one or two on the upper decks of each ship, breech loading, on a pivot, throwing an elongated shell of the maximum weight of 120 pounds. Their range and penetration was superior to the smooth bore of course, but there were no slow-burning powders at that time, and the explosive energy of the charge was too great to be withstood by any breech block that up to that time had been invented. So there was an entirely new field of discovery and invention to be entered.

It is not within the scope of this article to follow the steps that were taken. They were all progressive, and generally they were permanent advances. Encouraged by the liberal spirit of the ordnance department and aided too by the policy of the political party in power, they moved on abreast in all the solutions of the problem. Armor, guns and projectiles kept pace with each other, and the development and invention of slow-burning smokeless powders kept step with them. So that when the "Connecticut" was recently built in New York Navy Yard, it was possible to point to her as the best expression of offense and defense, except perhaps in the matter of size, that was presented by any navy in the world.

This stage of development was reached only a short time since. It is not to be said that the "Connecticut," nor any of the ships built contemporaneously in private yards, has exhausted the possibilities with reference to armor, guns or projectiles. So long as the war spirit, which great soldiers and sailors insist is the essential quality of a national life, continues, we will as a nation go on improving them. Fiction, in the form of romantic possibilities, will shape the way. But imagination is too vague to embrace the wonderful possibilities of scientific discovery. For example, shells are now made carrying a charge of graphite in their nose. At the moment of impact the graphite, meeting the armor, first lubricates the shell, assisting it in its passage through the armor plate. Back of the graphite is the charge of powder, and back of them both is the long rifled gun, all of them equally important. These are only steps on the way to a perfect development in the offensive arm, but they will be met as seriously by the defensive branch.

We are at this time interested in considering what the liberality of the Government has done for the promotion of the steel-trade interest. Let it be put this way: It has advanced it by leaps and strides far beyond any point it could have attained by reason of purely commercial influence. As always happens in like cases, a few steel makers took profit from this source in the first instance. But in the lifting up of the trade all of them shared the benefits. The North German Lloyd and the Hamburg-American steamship lines receive the direct benefits of the subsidies extended by the Imperial Government, but indirectly a score of lesser companies share in the common prosperity. The result is that the mercantile marine of Germany, like the steel trade, takes its profits from a source that does not meet it directly. When the Government of this country filled its ordnance yards with guns sufficient to equip the ships building and contemplated, and had also in hand projectiles ample for their magazines, the steel makers who had sup-

plied it still had the expensive plants on hand. They were then ready to appeal to the commercial trade. More than that, they were prepared to exact from that source the support for the maintenance of these plants.

The structural and railway steel product was reasonably provided for. But the tools that would cut nickel and chrome steel were not by any means in general service. The few that would do this work were made especially for dealing with armor plate, guns and shells. The lathe used to turn a shell was of itself a special tool. The mills that made the armor and the guns had such special tools. Other manufacturers did not need them and consequently did not have them. But when the makers of high-grade steels sold their product in the open market, the users of such steels found themselves in rivalry, and by the law of competition found it necessary to keep in pace, buy the high-grade steels and, as a sequence, to obtain tools that would handle them.

They are doing both. Cut out by the political influences that chiefly extended themselves in strongly protective States like Pennsylvania from successful competition for Government contracts, they still profited by the experience which the favored firms in those States enjoyed.

Fortuitously there arose about this time a demand for automobile steel of the first quality. It was not possible three years ago to deal with nickel and chrome steels by drop-forging. Within a year the mills have been able to drop-forge gears from nickel and chrome steel and to offer to the trade the equal of the best French and German forgings for that purpose. Knuckle and steering joints in automobiles, as everyone knows, receive the highest possible shocks, and these have been developed within four years in nickel and chrome steels.

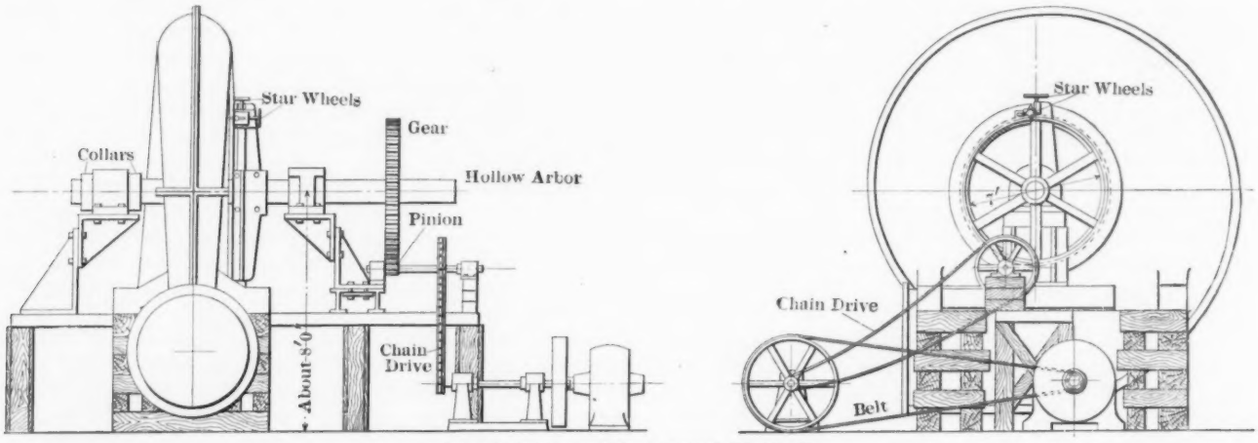
It is not to be understood that the work of machining such steel has not been vastly increased; the tool that cuts it has kept pace with the steel itself, so that now it is as easy to machine nickel steel as it was formerly to machine ordinary mild steel, provided one has the proper appliances.

Perhaps the most valuable and important result of the Government exactions for armor and projectiles has been, for mercantile purposes, the development of high-speed tool steel. With this steel I have seen a wheel of chrome nickel steel being turned with a cut one inch deep, a feed of ¼ inch, at the rate of 16 feet per minute. Causing a demand for such steels is what our Government has done for the steel industry. They are indirect benefits. But they are actual and of incomparably more value than just the making of guns and the forging of armor.

PILGRIM.

Machining a Large Casting in Place.

The drawings show how we bored and faced a large casting that could not conveniently be worked on a pit lathe or boring mill. It was absolutely necessary to have horizontal alinement. The casting was in four sections bolted together after



MACHINING A LARGE CASTING IN PLACE.

planing the flanges. The assembled casting, a large water wheel, was set up and leveled, and the boring bar adjusted. The water wheel has a base plate and this was put in place as shown and used as a support for the bearing brackets. Large gray-iron brackets were fastened on one side directly to the base plate, and on the other side to two I-beams which rest on the base plate, as shown. These latter might have been omitted but they afford a good rest for one of the journals of the intermediate gearing and besides allow the use of smaller brackets. To these brackets are then bolted other brackets which are adjusted in position so as to give the requisite alinement. The hight of the arbor is obtained by measuring up from the base plate which had previously been finished to dimensions. On the last mentioned brackets are bolted the bearings for the journals of the arbor. The arbor itself is a large hollow shaft. Two set collars, one on each side of one of the bearings, hold it in place. The boring and facing head is mounted rigidly on this arbor. Both movements of the tool are obtained by means of the usual star wheels, either one of which can be made to operate independently of the other. The drive is as shown, from the motor through sprockets and chain and spur gearing. The minimum diameter of the faced part was 7 feet and the cutting speed from 12 to 15 feet per minute. The job was satisfactorily done.

EDWARD BALBACH.

The Addition of Binary Fractions.

I was quite interested in the article by Mr. Halsey on the addition of binary fractions at page 628, not because I have used the method as I do not recall that I ever have, but it was a new one to me, and possibly my way may be new to some one else.

In some cases of addition of decimals where only three figures are used the added result may be too large or too small, and I prefer to leave the number a common fraction, which I usually add, cancel and add. For instance, take Mr. Halsey's group of figures $4\frac{3}{8} + 3\frac{1}{4} + 4\ 7/16 + 3/32 + 2\ 5/32 + 1\ 9/16 + 9/32 + 2\ \frac{1}{4} = ?$
$1 + 1 + \frac{1}{4}$

First I would add and cancel the ¼ and ¼ thus making 1; then cancel the 7/16 and 9/16 making another 1; then cancel the 3/32 and 5/32 which added equal ¼. This reduces and ejects the objectional numbers, viz., the smaller denominations, and it now becomes comparatively easy to add the numbers that are left. The addition would be about as follows: $\frac{3}{8} + \frac{1}{4} = \frac{5}{8} + 9/32 = \frac{7}{8} + 1/32$ and the addition of the whole numbers would give $4 + 3 + 4 + 2 + 1 + 2 + 1 + 1 = 18 + \frac{7}{8} + 1/32$.

By this method, using the above example, the total number of additions will be 12.

Near the conclusion of his article Mr. Halsey calls attention to the 7 partial additions of the fractions; to this must be added the 6 additions of the whole numbers, thus making a total of 13 additions in the example given. G. SCHNEIDER.

[My object in counting the number of

partial additions was to compare the labor of adding the binary and decimal fractions without taking into account the work involved in adding the whole numbers, which was common to both illustrations. —F. A. H.]

The Emerson Power Scale—The Cut Meter as a Tachometer.

Replying to your request at page 719 for the name of the makers of the Emerson power scale, I would say it may be obtained of the Florence Company, of Florence, Mass. This form of transmitting dynamometer deserves a wide popularity

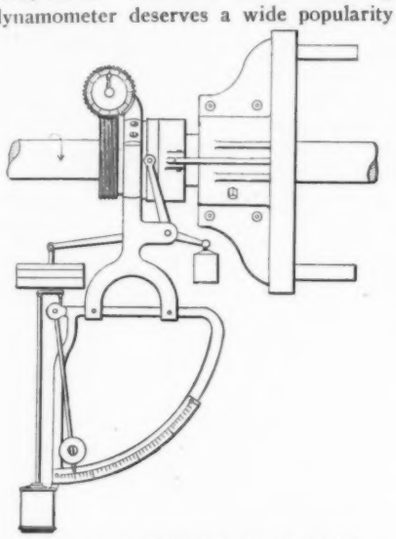


FIG. 1. THE EMERSON POWER SCALE.

owing to its accuracy and portability. It is but a trifle more complicated than an ordinary platform scale.

I have in mind one of these Emerson scales with an assortment of different sized shaft bushings, all of which are kept in a trunk-like box so that they may be sent as baggage at an instant's notice. It has aided in satisfactorily settling differences of opinion between landlord and tenant as to the amount of power consumed and proven useful in arriving at the power required under different conditions of working for tools not motored, as well as given efficiencies of small engines in connection with simultaneous indicator diagrams. The differences between the indicator card and the power scale figure is, of course, the power used up in running the engine itself.

Fig. 1 illustrates the scale. As may be imagined it is difficult for one observer to hold a watch, count revolutions and read the power scale at the same time. The doing away with the watch is possible by getting speeds with the cut meter. Fig. 2 gives a diagram which has been prepared for transforming such cut meter readings into revolutions per minute of standard diameters of shafting. The readings of the cut meter and the scale can both be taken at the same instant, then recorded and both figured out from the diagram later, when convenient.

Independent of any use with the power scale as outlined above, the cut-meter diagram will prove valuable as there are many places where one cannot get at the center of a shaft to use the ordinary revolution counter and besides this the cut meter is quicker than that instrument and also has the advantage of showing momentary variations in the speed, the same as more expensive tachometers do.

ROBERT S. BROWN.

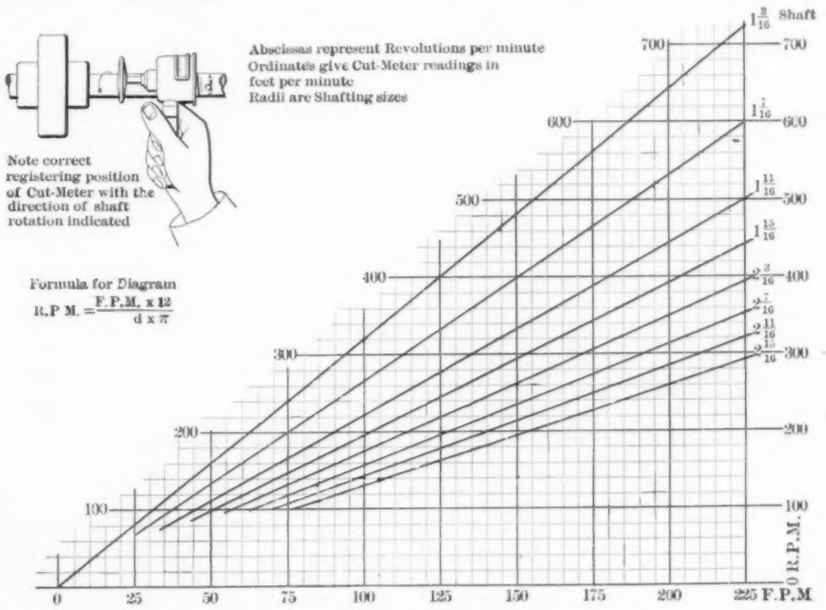
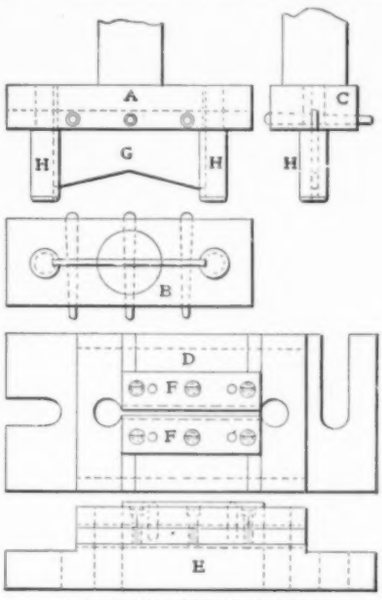


FIG. 2. DIAGRAM FOR OBTAINING RESOLUTIONS PER MINUTE FROM CUT METER READINGS.

Cutting Strip Metal to Length in the Punch Press.

The punch and die shown are for cutting off copper, brass or soft steel stock up to 6 inches wide and 3/8 inch thick in the punch press. *A*, *B* and *C* show how a very thin punch is so supported that it cannot spring even under a heavy cut. A blade 1/16 inch thick is quite stiff enough when made in this way to shear 1/4-inch soft brass, or copper 6 inches wide.

D and *E* show a plan and elevation of the die and die bed. The bed is made of gray iron or machine steel. The two tool-steel dies are held in place by three fillister head screws and two dowel pins each. The screw heads are sunk well



A SHEARING PUNCH AND DIE.

below the surface so that the dies may be ground in place. The punch *G* has shear starting from the steady pins *H* on either side. This reduces the strain and gives a clean cut. C. PETITJEAN.

London, England.

The Date of the 6-9 Perpetual Motion Determined.

The 6-9 perpetual motion is a deal older than 24 years. It is shown by Egyptian hieroglyphics of the Third Dynasty, supposed to date about B.C. 4000, and has reappeared regularly every nine years since that date. It is generally found traveling in company with the bisulphide of carbon engine, the tide motor, jet propulsion, etc.

JARJE.

Keeping Track of Press Tools.

At page 716, Part 1 of the present volume, you published an article on "Keeping Track of Press Tools," the writer of which claims for himself the credit of having put into operation the system he describes, whereas he was working under orders entirely from his then foreman in completing a system which we began eight years ago, the time when we first numbered and cataloged our press tools.

The system he describes is the outcome of necessity and gradual growth of a shop which began with one hand press, and is now one of the finest in the kingdom; and as one of several men who have

grown up in it, and have helped its progress according to our ability, I cannot see, or quietly permit one who came as a youth, when things were well established, who had no previous experience in workshop methods, and who was with us only three years, upon leaving to publish as his own invention, a system of working which was already in operation, and to which he only made additions on the instruction of one who was over him.

Nottingham. T. BENSON.
The Raleigh Cycle Co., Ltd.

A Milling Jig for Bolt Heads.

We have a lot of bolts and nuts which have square or hexagon heads with a round collar under the head, a few of which are shown in Fig. 1; these collars prevent us making them of square or hexagon steel in the usual way. In Fig. 2 is shown the milling jig for milling squares, hexagons, or any number that will divide into twelve, to any depth required, so as to leave the collar. In Fig. 2 is shown the jig rigged up for milling the squares on a special shape bolt head. In Fig. 3 the jig is shown in pieces; it will be seen that all the working parts are so arranged that they are entirely protected from the lubricant and cuttings. The base plate is of

FIG. 1. THE WORK.

cast iron turned all over and a hole bored to receive the sleeve of the plunger, which is operated by the lever shown in front of the jig. The sleeve and plunger are of tool steel hardened and ground all over, the sleeve being a force fit in the hole in the base plate, a spring is fitted under the plunger to keep it in place. The top plate is of gray iron and contains 12 hardened and ground steel bushings; inside they are taper to fit the plunger in the base plate. These bushes are force fits in the top plate, but before the bushes are forced in, a washer 3/16 inch thick is driven down to the bottom of the hole; these washers are tapped 24 threads—the object of this is, if a bushing needs replacing a long screw is screwed into the washer and butts on the bottom of the hole and so forces the washer out and the bushing with it, the washer being driven in again and the new bushing inserted. The washers are made a tight fit so that they will not turn with the screw; this simple contrivance saves a lot of time and trouble.

On the top plate is fixed a two-jaw self-centering Cushman chuck, the jaws of which are softened and bored 1⅛-inch diameter. Half bushings were made to fit the different articles that are to be milled. Two of these bushes are shown in front in Fig. 3. The handle of the chuck is made a fixture, as shown in Figs. 2 and 3; it also serves as a handle to pull the jig around. The indexing plunger is

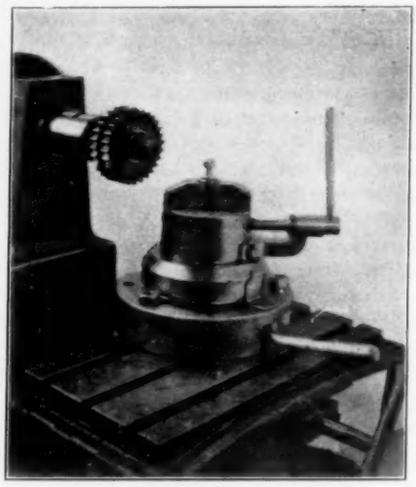


FIG. 2. THE JIG ON THE MILLER.

pulled out with the left hand and the right hand pulls the chuck and top plate around. the plunger lever being released when the top plate is at the hole required, which is graduated on the top plate and indicated by the pointer seen in Figs. 2 and 3. The plunger then springs into the bushing, though the operator generally gives the lever a push downward to be sure of it being in place. The top plate is held on to the base plate by a long, large bolt, to insure steadiness—shown in Fig. 3; it has a large hole through it and is made an exact length from under the head to the shoulder; it is case-hardened and ground a good working fit in holes in the base and top plates; the threaded part screws into the bottom part of the Cushman chuck, being passed up from under the base plate, and when screwed right home to the shoulder, the top plate and chuck

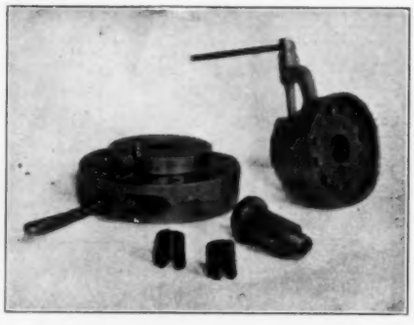


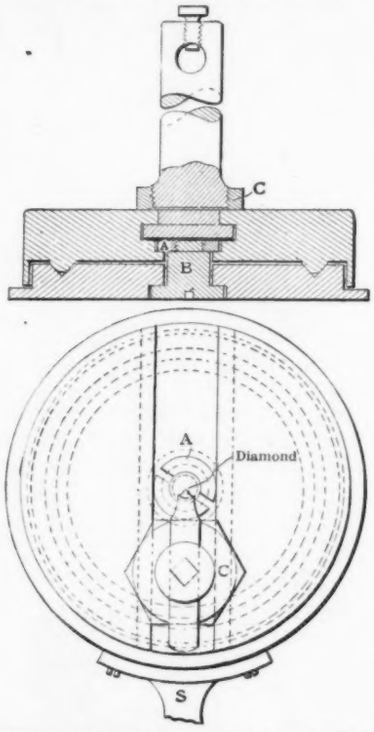
FIG. 3. THE JIG TAKEN APART.

turn freely without any shake. The underside of the top plate just comes on to the top of the base plate; this prevents chattering when the cutters are going across the bolt heads or nuts. We have a number of these jigs in use and find them very quick and accurate. When milling 2, 4 or 6 flats a gang of cutters can be used, as shown in Fig. 3; but for 1 or 3 flats an end mill would have to be used. This same jig can be used for drilling radial holes in round bolt heads, etc.; of course a drill would have to be running in the machine instead of the milling cutters shown. A. G. F.

Coventry, England.

Rig for Grooving and Rounding Emery Wheels.

The sketch shows a rig for dressing arcs on emery wheels; it saves time, as when once set it dresses a good true arc, which you don't have to touch up afterward. By sliding the diamond-holder along the slot from the center you get any arc, male or female, and no emery can get into the working parts. *A* and *B* are a nut and bolt for holding the top and bottom pieces together, and they should be adjusted so as to work nicely without play. *C* is a



FIXTURE FOR TURNING ARCS ON EMERY WHEELS.

nut for fastening the diamond-holder when set to the arc wanted. I think the rest of the sketch is plain enough to be understood easily. *S* is the handle. IKE.

An Equalizing Chuck.

Fig. 1 shows a special lathe chuck of the clamp variety having three segmental, floating jaws which equalize the gripping on six points of contact. It was designed for holding the iron castings as shown in Fig. 2 while undergoing the operation of facing the flange and the inner lugs as indicated in the sketch. The chuck holds them on the thin walls of the dome and distributes the pressure more evenly

and with a better grip than any other kind of chuck.

The main parts of the chuck are a face plate *A*, and a clamp in two parts, *B* and *C*, which are made of cast iron. Part *C* of the clamp is fitted so that its own weight will cause it to drop and open the chuck when the nut on the clamping screw *F* is loosened. The segmental jaws *D* are made

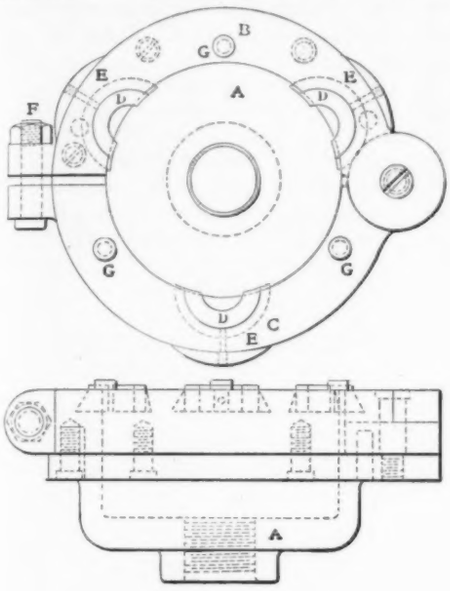


FIG. 1.

of tool steel and are hardened and tempered. They are fitted to move freely in their places, and are kept from going too far out of their position by the screws *E* which engage in elongated holes in the jaws. The pins *G* are bearing points against which the work rests.

H. E. R. MANBRAND.

Split Dies—Making Sectional Blanking Dies.

I have observed in your paper recently several articles on the making of blanking dies in halves or in several pieces, the advantages realized or claimed being ease of manufacture, repairs and replacement. I have in my practice for a good many years made practically all my dies in sections, getting no doubt the advantages claimed above but working for a different object, viz.: the securing of an abundance of shear in a practical and easy manner. The importance of shear and plenty of it cannot be overestimated in die work. A blanking die to cut well and continue to do so should be so made that the material of the punch shall never touch the die, and I have found that a good clearance in practice is 5 per cent. of the thickness of the metal intended to be cut; thus for material 0.031 inch thick 0.0015 all round should be allowed; for material 0.250 inch thick 0.0125 clearance is about right.

If a die is properly made and with these clearances, and if provision is made for maintaining the clearance during the cutting operation, the amount of work it will do is incredible. In practice, however, these conditions require some consideration if they are to be fulfilled; the materials of which the dies and even the press are constructed are in a state of equilibrium and they spring a few thousandths of an inch very easily, although capable of standing much greater stresses without actual damage.

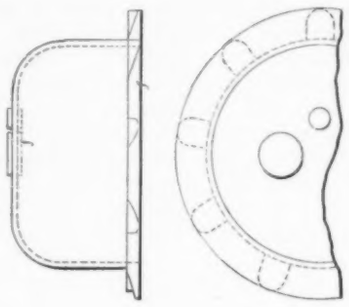


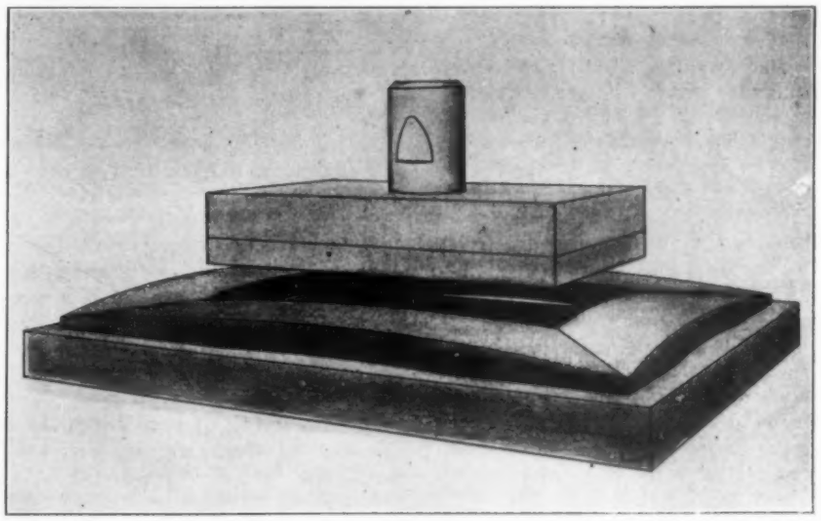
FIG. 2. A CHUCK AND ITS WORK.

In designing dies it is therefore important to arrange them so that the stresses at any given instant will be very slight, especially at the starting point, and the only practical way to do this is to provide plenty of shear.

It might be thought that putting the dies in sub presses would insure the correct alinement of the punch and die, but in practice no amount of guiding or fixing prevents entirely the slight movement under pressure; if the punch and die surfaces are flat or nearly so, when the cutting surfaces of a punch and die come together upon a plate the holding fixtures are forced to accommodate themselves to the alinement of these surfaces. If these surfaces are out of parallel, or if the plate is slightly thicker on one side or scale or lumps of tin happen to be there the pressure on the flat surfaces sets up a side stress which no press or fixing arrangement in reason can resist.

I do not wish to be understood as suggesting that the provision of plenty of shear dispenses with the desirability of using sub presses. I make all my dies of sub press form, the punch and die plates having lugs cast at opposite ends or corners; these lugs are bored to take cold-rolled stock, those in the die for a press and those in the punch for a working fit, I use two sizes only of guides, viz.: 1¼ and 2 inches diameter, which will be found to cover a very considerable range of sizes in a quite satisfactory manner. These guide bars are simply cut off, and the top ends rounded and then forced into the bosses of the die plate. Outside of any assistance the guides give in maintaining the exact alinement they are more than justified by the facility they give in rapid and accurate setting in the presses; they also insure the safety of the cutting edges in handling and in stores. It is probably unnecessary to add that it is only by using sub presses that a uniform clearance all around can be secured.

I inclose a photograph made from a drawing showing a simple rectangular die made up of sections in the way described, and from which it will be seen that the die is composed of four pieces of steel mitered at the corners. The procedure I have found best in making is first to design the die or, if this has been done, to take it to the drawing office and lay out the lines where joints of the sections will best come, indicating angles, dimensions, etc. Corners, whether square or round, should always be fitted at 45 degrees as this gives the strongest corner to the metal. Make additional joints wherever irregularity of shape occurs and generally



SECTIONAL DIE.

speaking the more sections there are the better, provided of course all are sufficiently large to admit of being securely fixed to the base plate.

The next step is to cut all the pieces from a bar of suitable size and shape, cutting at once to the angles by swiveling the vise and turning the bar over for getting reverse angles. All the pieces should then be heated and bent to a suitable curvature to provide a shear of say one inch in twelve. They are then planed on the concave side an amount almost, but not quite sufficient to remove the concavity, and then planed on the cutting edges to a suitable angle for clearance.

The punch and die plates may then be prepared, the guide-pins fitted, and the punch finished and fixed in its position upon the punch plate. This plate is then placed upon its guides and dropped into contact with the die plate, and the sections of the die are fitted around the punch and fixed by screws from the underside, and strong dowels (preferably taper) after which the sections are removed and hardened, then ground slightly upon the top or cutting surface and replaced in position, thus completing the die.

HARVEY E. BROWN.

London, England.

Brazing and Lapping Black Diamond Tools.

Fig. 1 shows a fixture for lapping black diamonds which are used in the forms shown at *A*, *B*, and *C* for finishing pieces made of brass and vulcanized rubber. The shank of the holder *D* revolves freely in the body *E* for lapping round-nose diamonds and the nurled nut *F* clamps it in position for lapping those of angular shapes. The splined collar *G* is graduated in degrees for setting the holder at the required angle. The adjustment for the required degree of clearance is obtained with the nurled and pointed screws *H*. The points of these screws hold the fixture in position on the wooden top of the rotary lapping machine. As will be seen in the illustration, the fixture can be adjusted to bring the axis of the holder to lie at various angles with the top of the lap, so that when a round-nose diamond is lapped by rocking the small handle back and forth the shape of the clearance will be a section of a cone. *I* is a movable weight sliding on the rod *K* for applying pressure to suit the various sizes and shapes of diamonds. Fig. 2 shows a crucible for brazing the diamonds into the bessemer steel shanks. It is made from a remnant of a worn-out crucible as used in brass foundries. A hole a trifle larger than the shank is drilled into it, into which brass filings and borax, and the shank containing the diamond are placed. It is then put into the fire in a forge and heated until the brazing is completed.

Fig. 3 illustrates a method I once employed for breaking a large valuable diamond at a given point. The diamond was of an oval shape, about ⅝ inch long, 5/16 inch wide, and ⅛ inch thick. The firm I was with informed the dealer that they would buy it if he would deliver it in two parts, cleaved in the center so that each piece would be 5/16 inch long and 5/16 inch wide. The dealer then informed them that the cleaving would highten the price of it considerably because it would have to be cut with a thin disk the edge of which would be charged with diamond dust, a slow and costly operation. I then informed the dealer that I would undertake to part that diamond at a given point in a short time, and he at once consented to have me try it, saying that he was willing to learn, because he never saw a diamond of that shape cleaved successfully without cutting it. I took a piece of bessemer rod ⅜ inch diameter, and 1½ inches long, into which I drilled and filed

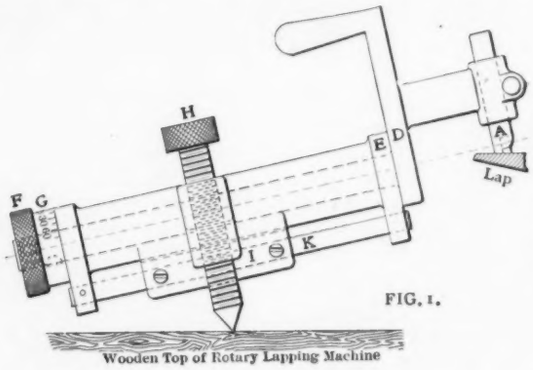


FIG. 1.

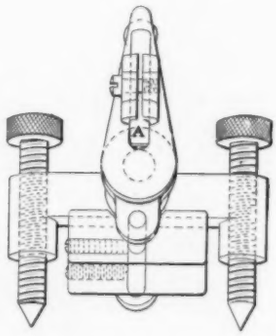


FIG. 3.

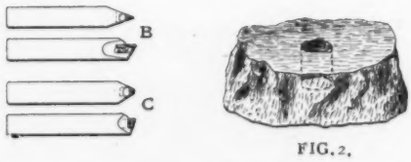


FIG. 2.

TOOLS FOR BRAZING AND LAPPING BLACK DIAMOND TOOLS.

an oblong hole to receive the diamond, and, after brazing it in, filed notches a measured distance from one of the ends. After reaching the diamond from all sides and giving it the breaking strain I was surprised to feel it break more nearly like a piece of slag instead of like glass as I expected, but the break was straight and clean, and at the given point.

H. E. R. MANBRAND.

A Shortcoming of the Technical Graduate.

It is conceded by all who come into contact in the drafting room with graduates of technical schools, and also by all such graduates themselves who will give an honest and unbiased opinion, that these graduates are lamentably lacking in one thing which is a detriment to their work for some time after they enter the drafting room.

I refer to the scarcity of dimensions so apparent on the early drawings of young engineers. They will turn out good drawings, correctly designed, drawn to scale, neatly shaded and neatly lettered, but if anyone but the one who drew it were asked to build the thing from the drawing he would be in immediate difficulty, and the chances are that the draftsman himself would have forgotten the sizes of some things before the ink was dry.

I am a technical graduate from the best school in the West and in looking back at my experience in that institution I can see that this condition is the result of a short-sighted policy of instruction which was pursued there as elsewhere. The instructors were, usually, and probably are yet, men who have gone through the university and passed into the faculty without having had a chance to get out and rub up against some of the difficulties that beset the engineer and draftsman, and who are without that saving sense of the fitness of things which demands completeness, with the idea of using the drawing as a means, not as an end.

It will perhaps be said that this is demanding too much of the young graduate, but when we face the fact that an army of young men each year enter the engineering professions, and a good many by the door of the drafting room, it must be admitted that anything which will fit young graduates for doing better work from the start is worthy of earnest consideration.

Although it is a fact that the graduates do not favorably consider the idea of working in the drafting room, yet it must be admitted that they can gain familiarity with practical engineering in that department as rapidly if not more rapidly than in any other.

It appears to me that the solution of

the problem lies in securing as instructors in drafting, men who have had years of practical experience in that line, who can glance at a drawing and instantly locate a missing dimension and who will show the students all the short cuts and how to attain the desired ends without the expenditure of more time than the job warrants.

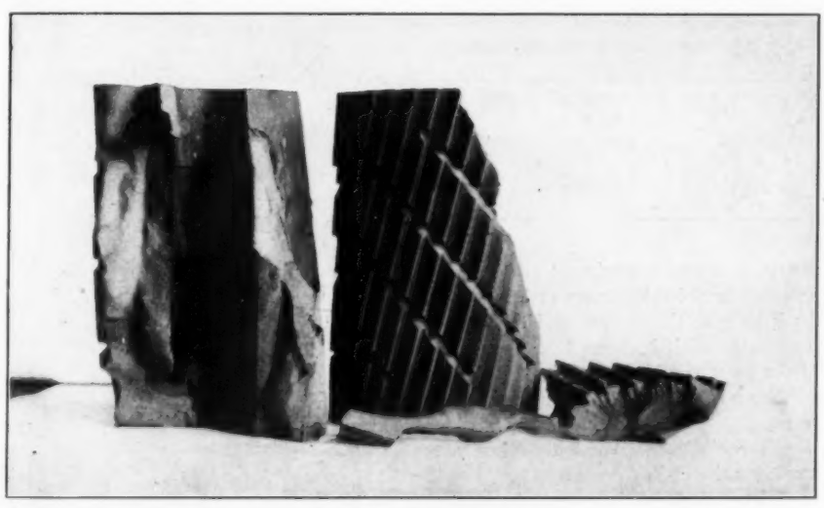
More work on tracing cloth should be done if, indeed, all drawings should not be traced, and more practice should be given in free-hand lettering.

If these things are not possible in the limited time allowed, then allow more time and give the subject the prominence it deserves, even if it be found necessary to omit descriptive geometry or perspective drawing which will never be used, or color tinting which is a curiosity.

ENGINEER.

A "High-Speed" Milling Cutter that Broke in Hardening.

My attention was called a few weeks ago to a milling cutter, which went to pieces when hardened. This cutter was about 10 inches long, and 6 inches diameter, and was made from "high-speed" steel. An examination of the photograph accompanying this article will convince the reader that the character of the break was something out of the ordinary.



THE BROKEN MILLING CUTTER.

The cutter so far as I am able to find out was treated carefully by a man thoroughly familiar with this class of work. It was heated in a specially constructed furnace which insured the exclusion of air to prevent oxidation. It was given the customary heat for steel of this character and then immersed in a bath of oil, with the results indicated.

As it is always desirable to obtain a reason for a result, this cutter was carefully examined, and the method employed when it was hardened was carefully inquired into.

Unfortunately the photograph does not indicate the appearance of the fracture, the surfaces of which have the appearance of a steel ingot that has been hardened and broken, without previous heating and hammering. The ends and several of the teeth of the cutter, have imperfections which closely resemble blow holes as they occur in an ingot that has not been "cogged" and "welded" under a welding hammer; this operation having the effect of welding out all blow holes, seams and other imperfections.

At times we see a bar of steel where the walls of blow holes would not properly weld, but would draw out into the form of seams, but it is an uncommon thing to see the imperfection in the form of a blow hole in a *finished* piece of steel, as the operation of hammering would close the hole even if the walls were not welded together. Yet I counted at least six well defined blow holes, one of these showing quite clearly on the back of one of the teeth in the photograph, and I trust this will show in the finished halftone.

A piece of this cutter was examined in connection with another piece of high-speed steel of the same make from another bar which worked all right, and the appearance of the two when fractured was entirely different; one specimen showing the coarse grain peculiar to steel that has not been "hammer refined," while the other showed a fine grain whose general appearance was that of a piece of high-speed steel that had been properly treated.

When investigating this matter I was informed that one manufacturer, at least, of high-speed steel did not hammer the ingots when they were to be used for large tools. Not believing this possible I made inquiry of people well versed in the methods employed when making one of the leading high-speed steels, and was informed that in making steel for a cutter of this size an ingot has to be cast that is several inches larger than the blank to be furnished; this is cogged and welded under a welding hammer, and the inperfections are welded out. After this the bar is finished by hammering under the finishing hammer.

Those of us who have had experience in working steel, and have had access to crucible steel mills know that many experiments have been, and are being made to produce certain results, or to produce an article that will accomplish certain results, at less cost. But it is generally considered the best practice to make the experiment where the steel is made, or to hire some concern to do the experimenting, rather than to let customers do it, when they pay the market price for the steel, thinking they are getting a standard article.

If any of the readers of the AMERICAN MACHINIST have had peculiar experiences when working the modern high-speed steels I am sure the results would be of value to others, and the results of special processes of treatment for special purposes would I believe make interesting reading, and prove instructive to those who harden or use this steel.

E. R. MARKHAM.

Draftsmen; their Qualifications, Positions and Salaries in England.

I was very much interested in G. F. Summer's article at page 706, and as he has placed before the readers the position of a draftsman in the States, I should like to say a word or two about similar positions over here.

The idea which is most common in England among young engineers, is to serve about two or three years in the shops, and then to become draftsmen. When they do this with the intention of settling down to a draftsman's humdrum existence, they make the most fatal error possible. What they should do is to get the ambition firmly fixed in their minds to go back in the shops after a couple of years of drafting-room experience, not as artisans, but more in the line of foreman or assistant foreman, with the idea of filling such a position eventually as assistant engineer, manager, feed and speed man, etc. If they are lucky enough to obtain one of these positions, they will have a far better chance of becoming engineers. In the shops, that is of large works, there are dozens of good positions to every one in the offices.

Most draftsmen in England are paid weekly, although, of course, a great number receive monthly or quarterly salaries. In a large number of cases, where weekly pay is in vogue, overtime is paid for; but to balance this, any time off for sickness is deducted from the man's wage. When the monthly or quarterly pay system exists, it is usual to pay for all time off and not for overtime. Some firms take advantage of this, and if they do, well, I prefer to be somewhere else.

As far as I know, before draftsmen are 21 they are paid on the same scale as the apprentices in the shop: that is, at 20 years, 13 shillings per week; at 19 years, 11 shillings per week. I believe the average wage to "loose" a man in England (that is when he is 21), is 25 shillings per week. If he stops with the same firm, and has not very exceptional qualities, his rate will go up annually in increments of 5 shillings per week. Of course it is the same as in everything else; there *are* exceptions.

I know a firm where men of 25 years of age get only 30 shillings per week. Who is to blame? Why both; the firm for not encouraging, and the men for stopping.

The time off in holidays, etc., is on an average as follows:

Indisposition	5
52 Sundays	52
52 half Saturdays	26
Easter	3
Whitsuntide	2
Bank holiday	1
Summer holidays (not including Saturdays and Sundays)	11
Christmas	2
Total	102

This gives us a percentage of 28 of the whole year or nearly 40 per cent. of the days worked; when looked at in the latter method of summing up, it indicates leniency on the part of the employers.

I fully indorse the remarks of Mr. Summers about the work of the draftsmen affecting every shop, especially with repetition work. A real good draftsman can, with forethought, help the jig and tool department. Not only this, but he will, with careful thought, simplify the patternmaker's work by judicious scheming, in many cases saving core boxes, which are often expensive, and avoiding many loose pieces which always give trouble. He should be able to decide whether it would be cheaper to make a forging or casting of any part; when laying out castings he might perhaps add a few projections which would facilitate the locating operations for machining. In these days of automatic machinery he should also be conversant with the size limits of work which the various turret and capstan lathes, etc., will take, at the same time bearing in mind that a great deal of time and trouble will be saved if each drawing is made so that it is used in only one shop.

The above remarks back up the idea that the best draftsmen are obtained from shop-trained men in the first instance. With reference to mathematical knowledge, I think a first-class draftsman should be an A1 mathematician. To be a good draftsman he must possess first-rate qualities as a designer. When getting out the design of a new machine many calculations are bound to be made (especially in the case where small weight is the prime factor), the hardest of which can seldom be taken from pocketbooks.

Personally I think that if an office has to have say six draftsmen, the most efficient way to fill it is to have three tip-top men to do the designing, standardizing and systemizing, and three juniors, one under each leading man, to undertake the work of detailing, tracing, clerking, etc. The alternative, which is generally found, is to have six medium men. Returning to salaries again, a good man at 25 years of age is worth 200 pounds a year, and at 30, 350 pounds a year. After that it depends on the man's progressive spirit and "chances which are fine things."

W. HARGRAVES.

Punching Holes in Block Links of Bicycle Chains.

The punch press is now employed to do such a great variety of work that one can look about him almost anywhere and see something that was produced on this most useful machine. One need not, however, expect to try an experiment on the punch press without having more or less trouble. As I describe this fixture and think of my experience with it, I must say it was one of the most troublesome jobs to get started that I have ever had. The fixture was to punch the holes in the center blocks of bicycle-chain links. We had several automatic machines for drilling them, but the proprietor thought they could be punched cheaper. I said they could, my fellow mechanic said they could not be punched (there was only one machinist beside me in the shop); so I got the job. At every failure—there were several—my fellow workman was there with his "I told you so," just to make me feel good; but the final results were such that I always recall the job with pleasure.

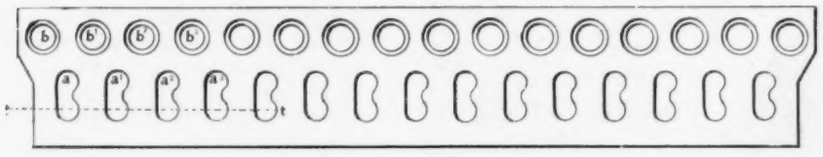


FIG. 1. THE JIG.

The most important question was, would the punches hold up? The chain blocks were 3/16 inch thick and the holes only 0.161 inch diameter, so the punches were considerably smaller in diameter than the thickness of the metal to be punched. The press was running 210 revolutions per minute and the proprietor would not consent to a reduction of speed. Owing to the small size of the punches we were afraid they would not hold up; but to make sure of this, we made a temporary punch, die and stripper, laid the chain blocks on the die and punched them. The punches held up better than we expected, but the chain blocks were mashed and spread. The next move was to make a tool-steel plate 3/16 inch thick with a hole in the center just the shape and size of the chain block, in which the chain block was a snug driving fit. We fixed up guides and a stripper on the die to locate and hold the plate. We then drove a block in the plate and punched it; driving in the next block drove the punched block out. The operation was slow, but we punched quite a number in this manner and learned that the punches would cause very little trouble from breaking, but would have to be ground quite frequently; also that we could maintain the pitch and size of the holes much better in this manner than by drilling, and that we did not require a stripper over the blocks, but only over the plate, as there was considerably more friction between the blocks and the plate than between the blocks and the punches.

At this point an interesting and unexpected feature of the job turned up. We intended to ream the holes after they were punched, but when we tried to ream them, we found we could not do it without annealing them. The holes had a smooth burnished surface that was so hard that a reamer would only stand up for two or three blocks. Whether this was due to the thickness of the metal in proportion to the size of the hole, or to the metal being so closely confined, or to the speed of the machine, I do not know, as I did not attempt to find out; but I would like very much to hear from someone on this point. We got around the difficulty by not reaming the holes at all, as we found that by making the holes in the die only about 0.001 inch larger than the punches there would be no break out of the metal in the punched holes, and the holes were so smooth that they could not be improved by the reamer. We found that the punches, too, became dull quicker

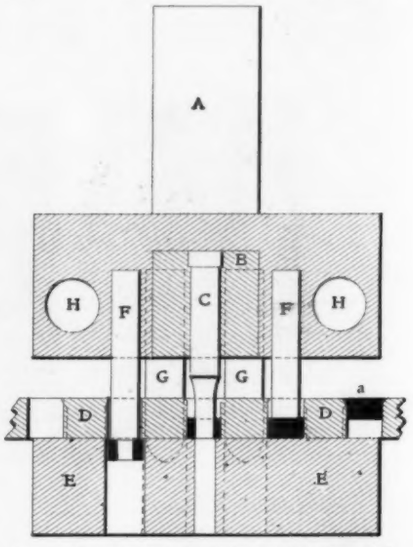


FIG. 2. SECTION OF PUNCH, DIE AND JIG.

than they would have done if more clearance had been allowed between the punch and die.

We now had experience enough to make a practical fixture for punching these blocks, which we did in the following manner: Fig. 1 shows the jig or plate for holding the blocks while they were being punched. It was made 3/8 inch thick, or twice the thickness of the blocks; this was done so that the holes *a* a^1 a^2, etc., could be made a snug driving fit for the blocks in the lower half of the hole, while the upper half was made larger so the blocks could be dropped into them easily. It was quite easy to fill this jig by dropping a block in each hole, and they would rest with their top sides about on a level with the upper surface of the jig, as shown at *a*, Fig. 2. The holes *b* b^1 b^2, etc., are pilot holes 3/8 inch diameter countersunk at the top. Fig. 2 is a cross-section on the line *t t* of Fig. 1 and shows the punches, punch-holder, jig and die. *A*, Fig. 2, is the punch-holder proper, *B* is a square block into which the punches *C* are driven—only one punch is shown, the other is directly behind it; this block fits closely in the recess made for it in the holder *A* and is held in place by a clamp and two screws in the holes *H* and H^1. It was necessary to make this block, because the punches needed grinding so often; we could take out the block, grind the punches and put the block back without resetting the die. We finally had two or three of these blocks for each machine and changed blocks when the punches needed grinding. *G* and G^1 are the pilots; we used two pilots because it was necessary to locate the jig very close, in order to always punch the holes in the center of the blocks. *F* and F^1 might be called pushers, because their purpose was to push the blocks in and out of the jig. The stripper is not shown; it was fastened to the bolster plate and only extended over the edge of the jigs. *D* is the jig and *E* the die.

In using this fixture we had three jigs to each press and three persons to each press—two filling the jigs and one operating the press. After a jig was filled the operator would run it through the press the same as if it were a strip of steel he was punching. At the first stroke the pusher *F* would push the first block from the loose to the tight part of the jig; at the second stroke *C* would punch the first block and *F* would push the second one in; at the third stroke F^1 would push the first block out of the jig into a box below, while *C* and *F* were working on two other blocks; after this a block would drop in the box at each stroke, so it took 17 strokes for 15 blocks. After the operator ran the machine a few days he punched blocks so fast that the punches got very hot and would not stand up for more than 15 minutes at a time. We tried a cold blast of air on the punches, but it did no good; so we had to reduce the speed of the machine to 160 revolutions per minute. This did very well, and the punches would quite often hold up for five hours; but I believe it would have been better to reduce the speed still more. I do not remember what amount of work was turned out per hour by these presses, but the results were so satisfactory that six specially built automatic drilling machines were discarded.

R. Earl Weinland.

Indianapolis, Ind.

Temporary Repair of a Large Pulley.

A friend of mine, who is master mechanic of a textile finishing plant, had a unique experience with a pulley a short time ago and the way he got out of the difficulty may perhaps prove interesting to others.

The main engine at the plant is a double-cylinder Harris-Corliss, running non-condensing from both sides and utilizing the exhaust for drying, etc. The belt wheel of this engine is 36 inches on the face and about 14 to 16 feet in diameter, driving to a jack pulley 84 inches diameter on the main line. This pulley is made of gray iron and is of the double-arm variety.

Everything was running nicely one day, when suddenly there was a crash and the main belt came flying back into the engine room, while a section of the jack-pulley rim went flying wild, to the detriment of several wooden columns in the immediate vicinity. Just what caused the break will perhaps never be known and whether the belt or the pulley broke first is also an unsolved mystery, but the plant was behind on orders and simply had to run in the quickest possible time.

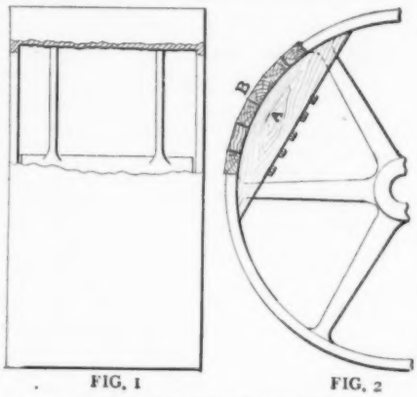


FIG. 1 FIG. 2

THE BROKEN PULLEY AND THE REPAIR.

While the men were clearing up the wreckage, the master mechanic kept the telephone operator hot giving him connections with all the nearby plants and supply houses that might by chance have a pulley like the broken one, but the nearest thing to be found was two feet too large and so he turned his attention toward a temporary repair until he could have one ordered to suit. The piece of pulley rim broken out was approximately the section between two sets of arms and was roughly from 2½ to 3 feet across, as shown in Fig. 1. As the rest of the pulley seemed to be in good condition, he had the carpenters get out some 3x12-inch ash, and prepare four pieces to fit the inside of the pulley rim as at *A*, Fig. 2. These were placed on each side of the arms, and each pair well bolted together, clamping them firmly to the arms. Some pieces of 4-inch ash were then sawed 36 inches long, and bolted to and across the pieces of 3x12, allowing the bolts to pass down between the pieces, countersinking the heads and using nuts and washers underneath. *B*, Fig. 2, shows the pieces in place. In the meantime a small engine had been moved into a convenient position for driving a section of this shaft, and the pulley and the cross slide from the shop planer had been rigged to hold the tool for turning, so it was a matter of a few minutes only to turn off the section of wood down to the size of the pulley.

Then the nearest coupling was loosened, and the pulley and section of shaft removed to some convenient horses for balancing. It took 136 pounds of lead to do this, and as it was run in between the pieces of 3x12 ash, there was little fear of its getting loose.

After erection, the main belt was replaced and the plant ran on the same as usual for over two months before it was removed to be replaced by the new pulley, and even then it seemed just as good as the day it was repaired. L. L. Arnold.

The Verein Deutscher Ingenieure—Other German Technical Societies.

I have read with much interest a note on the Verein Deutscher Ingenieure and its branch engineering societies.

You assume that one reason for the flourishing state of the various branch engineering societies is due to the lack of other engineering societies, so that engineers of all classes are members of the Verein Deutscher Ingenieure. The latter statement is true; any engineer in any line can join this society. That, however, does not prevent the flourishing of many other societies, some of them very considerable ones. I am myself a member of the Schiffbautechnischer Verein, which takes care of shipbuilding and allied affairs, and although one of the newer societies, is also one of the most flourishing. I am also a member of the Verein für Eisenbahnkunde, which embraces practically all of the railway engineers of Germany. This society also has many branch societies, and I know also that there is in existence an electrical society with a very large membership list and I believe also with branch associations.

The flourishing condition of the Verein Deutscher Ingenieure is probably due to the fact that it will accept for membership practically anyone who can call himself an engineer or who can state that he is interested in engineering matters. You

can see that this opens the way to practically anyone who cares to join. The desire of practically every draftsman, technical school graduate or other interested person to join is not interfered with by any high membership dues. It is, in fact, cheaper to join than to remain outside the pale for anybody who wishes to receive the *Zeitschrift der Vereins Deutscher Ingenieure*. This publication, as you probably know, is one of the foremost engineering publications issued, and is furnished to members gratis. A non-member would have to pay a higher subscription for the publication than the membership fees amount to, and these are only about $5 per year with an added charge for mailing the publication, to cover foreign postage for foreign members.

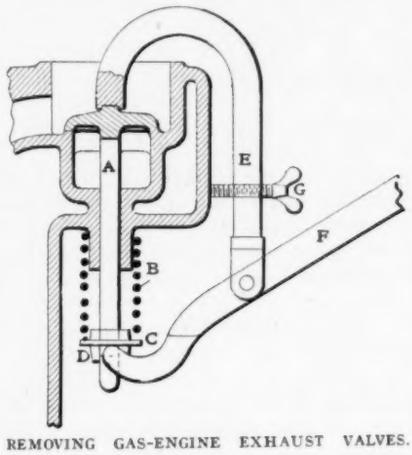
It seems to me that the fundamental reason for the difference in the development of our engineering societies and this German one is to be found in the fact that our American societies have largely followed the lead of the English engineering associations, in assuming that membership gives a certain guarantee of engineering standing. That this is an assumption based on fact is borne out by the admission requirements of our own and the English societies. In Germany that is not the case; membership in a society there simply proves that the member is interested in the aims of the society and in the social meetings with fellow-members. As practically all of the branch associations of the Verein Deutscher Ingenieure have meetings every two weeks (my memory may here be a little at fault and the time may be once in every four weeks), ample opportunity is given for such intercourse.

The low fee of the Verein Deutscher Ingenieure is characteristic of others also. In the Schiffbautechnischer Verein, for instance, the annual dues are only 30 marks (about $7.50). In the Verein für Eisenbahnkunde the fee for resident members is only 10 marks per year, and this includes even the light lunch served on the occasion of the monthly meetings. For non-resident members the entrance fee is only 30 marks (about $7.50) and annual dues of 25 marks (about $6.25), life membership 100 marks (about $25.00).

Philadelphia. HENRY HESS.

Removing Gas-Engine Exhaust Valves.

The device is intended to assist in removing gas-engine exhaust valves of the style shown in the sketch. *A* is the valve, *B* is the spring, *C* the spring washer and *D* a key to hold washer in place. To remove the valve it is necessary to lift up the washer *C* so that the key *D* can be disengaged from the valve stem and slipped out. As these springs are very stiff it is considerable trouble to compress them sufficiently with the hands and often the services of another man are required to hold the valve down. The device shown consists of a hook *E* engaging the top of the valve, a lever *F*, pivoted to the end of *E* having a forked end engaging the washer *C*. The end of the lever *F* is made the shape shown so that the key *D* can be readily slipped out between



REMOVING GAS-ENGINE EXHAUST VALVES.

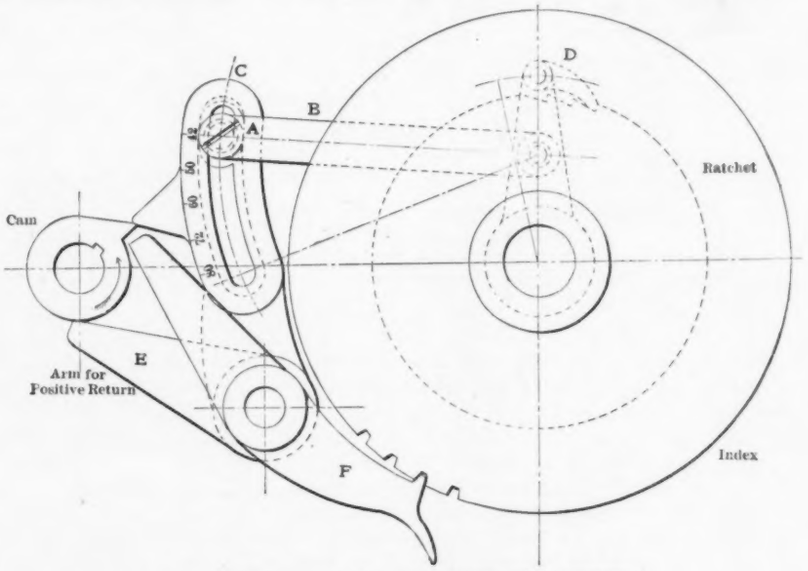
the jaws at the end when the spring *C* has been compressed. *G* is an adjusting screw to steady the device and keep the point of *F* in position under the washer *C*. With this device one man can take out or put in the valves with ease.

W. ALTON.

Indexing Mechanism for Automatic Gear Cutters.

On some automatic pinion- or gear-cutting machines of the small type such as are made by watch-tool manufacturers, the indexing mechanism is somewhat complicated and hard to adjust for the different numbers of teeth which are required to be cut, there being several cams and numerous set screws to bother with; but the index mechanism shown in the sketch is simple as well as quick, and may interest some readers. To adjust it loosen screw *A* and move arm *B* to the required graduation on lever *C* according to the number of teeth to be cut, then tighten and it is done, there being one cam which gives the required motion for all the parts. This pulls the pawl *D* back positively by an arm *E* fastened to lever *C*, releases the pawl *F* and moves the index plate forward until this pawl, which at this time is riding on the plate between the notches drops into place. There is a spring (not shown) which holds the pawl *F* in place in the notch. Reference to the sketch will render further explanation unnecessary.

ARTEBE.



INDEX MECHANISM FOR AUTOMATIC GEAR CUTTER.

The Selection of Material for the Construction of Hydraulic Machinery.

Referring to Mr. Falkenau's article at page 6, and to the comment of Hydraulic Engineer at page 186, Vol. 29, Part 1, with reference to the failure of the Menai Straits bridge cylinders, the following is extracted from "Strength of Materials," by Sir J. Anderson. Speaking of the weakness in a casting consequent upon a sharp change in the direction of surface, he says:

"A good illustration of this kind of weakness was afforded by the accident which occurred in raising the Britannia tubular bridge. The hydraulic cylinders were originally made with a flat bottom, like that of a drinking glass; the cylindrical part of the casting had the crystals radial from the inside, but in the bottom part the crystals were perpendicular to the flat end, and at the points where the two different arrangements of crystals come together at an angle—namely, at a line drawn from the inner to the outer corners—there were the lines of weakness. Hence it was that,

although considerably thicker, the cylinder failed at those points.

"The second or substitute cylinder was made with a hemispherical end, and in it the radiating crystals were all arranged in lines more nearly parallel, although of course not truly so. As thus made it was found to be amply sufficient in strength, even with the same amount of metal in the mass. The foregoing was the means of drawing public attention to the subject."

I had this subject explained to me years ago, and the foregoing was then quoted in support of the necessity of ample fillets to castings. The above is interesting as both your contributors state that the failure was due to porous and spongy cylinders.

In connection with the porosity of even good close-grained cast iron, the proprietor of a works that turned out numbers of shell-banding presses acquainted me with an interesting fact. These presses consisted of two circular cast-steel frames with about 12 small hydraulic cylinders arranged radially, and he advised users to run with oil in preference to water, complaining to me that they all followed his advice, and as a consequence he never saw the machines once they had left the works, i.e. repairs were never needed. He then informed me that about 1 gallon of rape oil per machine was wasted by being soaked up by the cylinders.

The iron he used was one-third cold-blast pig, and better, closer grained castings I never saw. A. L. Haas.

London, England.

Jones' Contract And How it Came Out.

One of my apprentice boys came in to see me the other day. He had been with me four years, and I used to say that he would make good by and by; but when he came in the other day he didn't show any signs of it. He had all the look of a fellow who had broken an inch drill at the bottom of a deep hole, or had otherwise run up against something that was one too many for him; but I didn't let on that I saw anything out of the way; just shook hands and said, "Well, how are things going?"

"They ain't going at all, Mr. Press; that's why I thought I would come down and see you."

"What is the matter? The last time I heard from you you were doing fine. Heard you had got out a patent of some kind that was a good thing."

"Well, that is all true enough. I did get out a patent that is a good thing, but it is buried so deep I guess it will never come to light again."

"Well, Frank," said I, "sit down and tell me all about it;" and so he did.

He had been working down at the Silicon Company; they make a variety of sand-spinning machines, and among the lot they make a sand-rope machine. Frank got interested in that branch of the work, and saw how he could make a rope machine that would discount theirs at least 50 per cent. He went to work and made all his plans and sketches at home; got out his patterns; filed the work all up in the kitchen; did what little tempering or forging he had to do in the cook stove; and when he had it all finished, tried it after dark out in the back yard. His wife held the lamp so that he could see what he was doing. It worked to perfection, and would spin more rope in less time, and do it more evenly, with one-half the work of the one the Silicon people made.

Now Frank is a cautious kind of a fellow, and so not to take any chances whatever, he flung up his job and went over to the Rivet Company to work. Then he put in his application for a patent, stayed there until he got it, and everything was all right. Then he went to the Silicon people and told them what he had, and showed them his model, and also the patents, and demonstrated to them what a good machine it was.

They admitted it was way beyond anything they had or ever dreamed of having, and wanted to know his price. Frank was modest in his demands, and told them frankly he cared more for a good contract than he did a lump sum, and the thing finally ended up in their buying the patent outright for a nominal price, with the provision that Frank should make all the rope machines which they wished manufactured, at a certain price, named in the contract.

It was further agreed that Frank should furnish all materials, castings, patterns, etc., at his own expense, the company giving him a price for the finished product. He was foxy, or thought he was, and had it in the contract that the first order should only be for 100 or less, and all orders after that should be at the discretion of the company.

Frank had all the papers carefully looked over by a lawyer he knew to be honest, who said he didn't see a hole or flaw of any kind in them.

The deal was closed, Frank went to work, made his patterns, got out his castings, finished and delivered the first 100. There was not a word of fault found with them in any way. The payments were made and Frank commenced to perfect his tools and get in more castings, so as to be ready for the next order. When he did get things in first-class shape to handle orders of almost any size, he began to wonder why the next order didn't come along. He finally went over and had an interview with the manager.

"Well, Mr. Jones," said he, "we still have all those machines, and I can't tell you when we shall want any more; it don't look as though it would be very soon."

"Why! What is the matter with them?"

"Nothing, nothing—"

Frank was rather mystified, and after a while came away and commenced to look into the matter. He soon found out what the trouble was. The machine which they had been making was the best there was on the market, Frank's excepted, and his had only been secured for the sake of putting it on the shelf. The 100 which he had made were stored away in the cellar, and as Frank said, "They are likely to stay there until the Judgment Day. I have got $600 worth of patterns, tools and castings that are no earthly use for any other purpose; I might as well have stored these with them for all the good they will do me. Do you wonder that I look and feel as if I had been knocked out?"

"Well, Frank, you are not the only one who has been served that way, and I am going to tell the boys about this. Shall I?"

"Do," said he. "It may save some of them from falling into the same hole I am in now." A. P. Press.

Cast-Iron Beams.

Having been very much interested in Mr. Osborne's article, at page 832, on Cast-Iron Beams, I have turned the searchlight of my correspondence school learning on the subject with the following results.

The section modulus is what we are after, and by figuring it, I find that it is about $\frac{0.037}{0.66}$ or 0.055. The modulus of rupture or ultimate strength of flexure is given as 38,000 pounds per square inch.

Then for 12-inch span, the breaking load $W = \frac{4 \times 38{,}000 \times 0.055}{12}$, or $W = 700$ lbs. This should be the breaking load for the beam. It is evidently low and I, for one, am glad it is, and I suppose that those who set it purposely set it so. I would expect, however, a small section to be relatively stronger than a larger one, due to the larger proportion of hardened scale, and smaller chance of blow-holes.

In regard to the fiber stress or "modulus of rupture" chosen, I might quote Professor Merriman who says: "Formula may, however, be used for the rupture if the fiber stress be taken as a certain quantity intermediate between the ultimate compressive and tensile strengths of material. This quantity, which is called the modulus of rupture, has been determined by breaking beams and then computing fiber stress from formula."

It would seem that the master minds must have gotten after the subject in much the same manner as did our oil-country friend, that is, by trying it, and they probably tried a good many different sections and mixtures. As they seem to be on the safe side we can evidently stick to them.

It is an undoubted fact, however, that the beam should be strongest with the greatest area in tension. With the neutral axis passing through the center of grav-

ity, and the T reversed, the fibers in tension are 0.34 inch away as against 0.66 inch with the flange up, and one would expect this to be the ratio of strength with a material having such wide differences between its compressive and tensile values as cast iron.

Why cannot someone who knows tell us why we have this erroneous idea that sections are as strong one way as another, and that when we figure a beam and base our calculations on "modulus of rupture," we are really making an engineering calculation; it seems to me that for some beams in cast iron we are going astray if we do so. C. 41770.

I read with considerable interest the tests of cast-iron beams given at pages 832, 833, 834 as I have used a considerable number of such beams in furnaces and drying ovens where wrought iron and steel could not be used on account of the heat and gases from the fuel.

The early part of my practical experience was in a large foundry, which was in a constant process of enlargement and improvement and much of my work was in the direction of making these improvements.

We very naturally used cast iron more than would have been the case if we had not had several cupolas and plenty of floor space handy as well as being compelled to do so by the reasons given above.

While we were not as exact in our calculations as we might have been, we still used some mathematics, and if our friends from the oil country have a copy of Church's "Mechanics of Engineering" handy they will see on page 279, edition of 1891, the mathematical reason for the use of cast-iron beams in the inverted T, or, as the author puts it, "more material is placed in tension than in compression." As cast iron is stronger in compression than in tension this form would naturally follow when it is used in a beam.

Again in Thurston's "Materials of Construction," page 404, edition of 1890, he says: "When the metal is stronger in compression than in tension, as is the case with cast iron, the extended side should be enlarged; this was done by James Watt when making his ⊥ -beam, and by Fairbairn and Hodgkinson, who first made the I beam, in which the compressed flange has an area less than that under tension in the same proportion that the resistance to compression exceeds the resistance to tension. For ordinary cast iron these areas are as six to one."

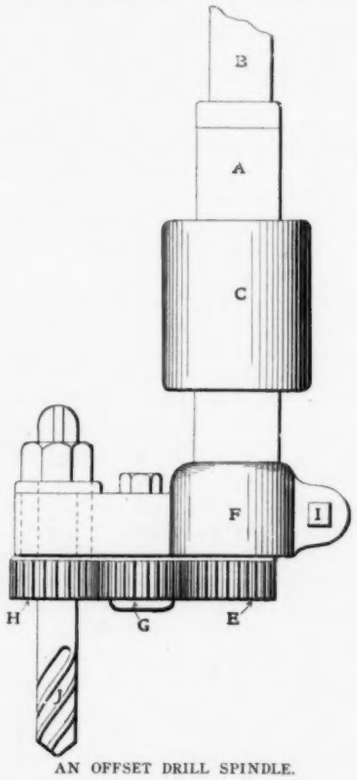
Hodgkinson's formula as given by Kidder, page 555, is as follows: "Breaking-load in tons equals area of bottom flange in square inches times depth in inches times 2.426, divided by clear span in feet." This rule will give good results if properly applied, like all other rules and formulas. Reference to the same page will give the reader who is after something closer and more modern another formula which will require more figuring and some mathematics.

In the practice mentioned above I can only recall one case where we used a beam (cast iron) of I section and in this case the top was used as a base for several brackets and was neglected in figuring the strength of the beam. COPE KNOWLE.

[Our correspondent remarks that he has sent us this communication "not so much for the purpose of calling attention to the antiquity of the inverted T beam as to counteract a tendency to a feeling that books do not give information that can be used by a practical mechanic. The use of books alone will not give results, but the proper use of a book together with sound practical common sense will often pull a man out of a difficulty that would otherwise be almost insurmountable. The principal value of an education is to teach a man where to look for the information he wants, and to find it; experience will teach him how to apply it." We consider these reflections worthy of publication along with the letter.—Ed.]

An Offset Drill Spindle.

Twenty years ago I was working on some of the first self-contained portable steam engines with center cranks. The cylinder, bed and shaft bearings were all cast in one piece. When I came to drill the steam chest for the valve stem I could not get it under the drill as the shaft bearings were in the way. The sketch shows how I got out of my trouble.



AN OFFSET DRILL SPINDLE.

A is the quill, *B* is the spindle, *C* is the bearing for the quill. A casting *F* was made to clamp on to the quill by means of the bolt *I*, it carried a train of gears *E*, *G*, *H*, *E* being secured to the end of the spindle, *G* an idler and *H* having a socket into which the drill *J* fitted.

J. W. MCFARLAND.

Slide-Rule Wrinkles—The Decimal Point—Trigonometric Functions.

Slide rules are growing in favor each year, not a little of this deserved popularity being due to admirable improvements insuring ease of operation and accuracy.

From time to time AMERICAN MACHINIST contributors also have lightened the mental labor of slide pushers and here are a few more suggestions along this line, some being points in general and others referring especially to the ordinary 5- or 10-inch Mannheim rule.

In multiplication and division, the location of the decimal point still proves troublesome to many, and while inspection of the problem often serves for short operations, longer formulas prove troublesome. A brief method is very desirable; the rules given have been too complex, involving mental combinations of "slide to right," "slide to left," "subtract one unit from sum," "add one unit to difference," etc. To avoid this confusion, let us state a simple, *general* rule, as follows:

Using the lower scales *C* and *D*, the number of units in the result,

In Multiplication = Sum of Units in Factors;

In Division = Dividend Units — Divisor Units.

The *only exception* to this rule is when the slide projects to the *right*. For each time it so projects, apply the general rule above and

In Multiplication, Subtract One Unit;

In Division, add One Unit.

Therefore in solving problems involving these operations we have only to note how many times the slide projects to the right and make the exceptions as stated. Absolutely no reference has to be made to the number of times the slide goes to the left. Take this problem in multiplication.

$$131.2 \times 68.4 \times 0.31 = ?$$

We note mentally that the slide projects once to the right, therefore, applying the general rule and subtracting 1, there are $3 + 2 - 1 = 4$ units in the answer.

Or in division:

$$\frac{294.8}{18 \times 0.31 \times 14} = ?$$

The slide projects twice to the right so we add 2 to our general formula giving $3 - (2 + 2) + 2 = 1$ integer in the quotient.

A more complicated example, however, sometimes renders it difficult to "keep tabs" mentally on the number of slide projections to the right. If for each time

in multiplication and for each time in division a straight line is marked and then the excess of the sum of one group over the sum of the other group is noted, we can at once correct our general rule. Illustrated as follows:

$$\begin{matrix}1\,1\,1\,1\\1\,1\,1\end{matrix}\ \frac{13\times 152\times 18.1\times 38\times 0.22\times 0.034\times 980}{12\times 39.2\times 56\times 0.004\times 480}=?$$

Each straight mark in the upper group, of course, represents a slide projection to the right in multiplication; each in the lower a slide projection to the right in division. Since the sum of those in the upper exceeds the sum of those in the lower by 1, first subtract the 1 from the sum of the units in the dividend and then apply the general rule for division, giving $10-7=3$ units in the result. Remember that the units in the decimals 0.034 and 0.004 are negative, being —1 and —2 respectively. Had the excess been in the lower group, we should first subtract from the sum of the units in the divisor before proceeding with our formula for division. Had the groups been equal we could apply our general rule at once, the corrections balancing each other. We have pre-supposed that the above problem has been solved by the correct method of alternately dividing and multiplying to save slide settings, and after short practice it will be found that even some of the straight marks need not be put down, as a mark for division will be at once balanced by another for multiplication by moving the runner to the next factor in the dividend without changing the slide's position to the right.

The order of operation can be whatever desired, and a little different method of operation of this same problem might give a different number of marks above and below the line, but the excess of one group over the other would always be equal.

The above processes are much simpler than a first reading would indicate and give a short, easy method for locating the elusive decimal point.

It is rarely that we see anyone using the sine, tangent and logarithmic scales on the reverse of the slide, although the occasion may arise at any time, especially for the engineer and draftsman. Said occasion usually can't be met, for the forgotten rules of manipulation are not where they should be, on the scale itself, but in a direction book, whereabouts unknown.

Here's a short way out of the difficulty.

Stamp or scratch on the front face of scale *A* directly over the middle index the word SIN. About half way between this point and the left index on the same scale mark the figure 0 and about half way to the right index the figure —1. Also directly over the right index the letter S. On the lower scale *D* at about the middle, stamp TAN O and directly under the left index the letter T. This supposes that the slide-rule is provided with two openings on the back, one at each end, so that the angles for sines may be read on the back of the slide through the opening at the right-hand end, and the angles for tangents through the opening at the left-hand end, the wood covering up the tangent scale if we try to read the latter angles at the right-hand end.

Fill in these letters and figures with India ink. Also on the paper table on the back of the rule will be found room to print, after scraping off the shellac, "Read sins under S; tans over T, or reverse slide and line up indices." Re-shellac.

These little reminders will be ever ready to inform us that for sines we set the slide to give on the reverse side the angle and read under the letter S the sine required. If the left index of the slide is to the left of the middle index of the scale *A*, the "characteristic" is 0, or there are no ciphers to the left of the decimal point, and if the left index of the slide is to the right of the middle index of scale *A*, the characteristic is —1 and a cipher is placed between the decimal point and the first figure. For instance, the sine of 10° 50′ = 0.188 and of 3° 35′ = 0.0626. The tangents are read over the letter T on scale *D* and the characteristic is always 0.0. If we have a large number of angles to solve, we can reverse slide and line up the end indices, reading sines and tangents directly.

For those understanding logarithms, the logarithmic scale gives surprisingly good results, being especially useful for high powers and roots. Take the example:

$3.82^4 = ?$ By scale log $3.82 = 0.5819$.

$0.5819 \times 4 = 2.3276$. Set slide to log, 0.3276 and corresponding number on scale *D* is 212.5.

Again

$$\sqrt[4]{2861} = ? \quad \text{Log. } 2861 = 3.456.$$

$$3.456 \div 4 = 0.864.$$

Set to 0.864 and read 7.32. These results were those actually obtained, not "juggled" for the sake of this article.

CHAS. G. RICHARDSON.

The Worker as a Thinker—House Building as Recreation.

Now that Mr. Osborne and Mr. Plaisted have not only acknowledged a lazy streak in their natures but have gloried in it, I suppose it is in order for us lesser to follow suit. Nevertheless, I am not willing to take what either of them say literally. I think neither of these men have the slightest idea of what it is to loaf. I can illustrate the point which I wish to make better by relating an incident than in any other way. Along the line of the Boston & Albany Railroad coming from Boston, just a little while before you get to Springfield the road runs along rocky hillsides where men have piled rocks in walls dividing up the landscape into tiny pastures. I was through there a few months ago with two gentlemen, both closely identified with engineering progress. One of them made comment on the wasted energy of our forefathers who attempted to subdue this rocky land when there were acres on acres of land to the west which needed only the least of attention to respond bountifully, and he spoke especially of the labor of building the stone walls evidently to no purpose except to leave passage way between the larger rocks for the cattle to walk through. "But, Mr. H.," I said, "look for the results of their labors in these fields just where you have previously been looking. A very large part of the engineering feats of the world have had their genesis right here in these fields. While these men labored with their hands they were thinking, and thinking to good advantage too, as we can see wherever we go." And just so it has been through all ages; the men who have thought the thoughts that have moved the world have labored with their hands. And this is as I believe it should be; not that the scholar and the craftsman should be two distinct beings, but that the scholar should be a craftsman, and the craftsman should be a scholar.

J. C. Graham gets at this on page 746, but I wish he had gone a step further and admitted that apprentice's environment in any ordinary machine shop would not be conducive to his studying out things for himself. To see what I mean let us see what is done for a boy in school, say a technical college, since that is in our line. He goes to school and finds shop and laboratory equipment spread around. He finds teachers who shake his hand and enthuse over him and tell him how valuable an education they will give him and he finds a friendly Bursar who relieves him of some of his worldly goods. Then he starts in. He buys certain books, he is assigned certain lessons. He studies them, but doesn't understand. He goes into class. The professor says that the point he did not see is perfectly plain and clear if he had only read his book, and assigns another lesson. Does our student write to the papers and say that he has not had a show? Not a bit of it; he talks with the other fellows and they all tell him that it is all in the book. He finds that they are all digging out just such things, and more than that he has paid good money for his tuition so he just sticks right to it, and he gets his money's worth not by being coaxed and coached and pulled through, but by having to get certain lessons along a well thought out line. In the shop there is neither incentive. He doesn't *have* to get along just so fast and he doesn't have the example of his mates. Now see what a tremendous advantage there would be if we could only have—but I did not start out to talk trade school, I only wanted to dispel Osborne's and Plaisted's illusion that they are loafers.

I see Mr. Plaisted is reading Elbert Hubbard. I don't believe in it. I don't

subscribe to *The Philistine* myself and I think a great deal, in fact most of what is therein contained has been better said before. But, nevertheless I always buy a copy every month just to "see where he has broken out this time."

"To maintain order, excellence and harmony in the territory covered by one's own hat" will keep one fairly well occupied is certainly good and true, for I heard the same thing read out of the Bible today in other words. But Fra Elbertus and Brother Plaisted have no doubt noticed that there are a lot of us that can do the large high-sounding things. But those that can keep the area under their hats in good order are so few and far between that they may safely be neglected. An ordinary human being who keeps watch of his own vagaries and shortcomings steadily gets so disgusted that he must turn his observation on his brothers to escape the mad house for himself.

After reading Wagner's "Simple Life" and reading about the Rooseveltian Strenuous Life and all the other lifes it must seem to the lay mind that life is a very funny proposition after all. For the sake of those who are inclined to take it seriously, I wish to say that I have found a very easy and simple solution of the world. I have thought of writing a book on the subject but as I have an even lazier streak in my make up than our friends to whom I have referred so often, and as the subject really can be quite as well treated in a few lines as in a book, I will present it here.

Mrs. Entropy and I decided several years ago that the city was an artificial thing to support an artificial people in an artificial society. We also decided to quit paying rent. We had no money, having given it all to the landlord; so we decided to build a house. This itself is nothing strange, being the usual custom. But one day we ranged ourselves and all the little Entropies (who come along in a sort of adiabatic scale) alongside the stage office, and took passage for the country. Our credit was good for a small lot of land and a little semi-portable cottage that could be rebuilt to suit our immediate needs. So we camped inside and began to rebuild. We planned our house as we wanted it to be ultimately. Then we went over it and cut off everything that could possibly be spared. We bunked the little Entropies in the corners, left out a great stone fireplace, and also the second story. When we had ten dollars we bought lumber. When we had ten more we hired a man to put in place what of the lumber I did not have time to use up. As fast as we saved our rent money we put it into the house. We literally built the house over our heads just as does the painted nautilus, or our friends who watched our progress said, "like a snail." The first year I put in the foundation for the fireplace, so as to get rid of some stone in the front yard. Each summer I have made a start at building it, but either my back or my lack of skill as a stone mason stopped the job. This year it is done, of reinforced concrete. In fact this season will almost complete the whole job, a house and lot that would have cost upward of $2000 built out of nothing but saved rent and perseverance in using spare moments. Any man with any mechanical instinct, and a wife who is willing, can do it if he wants to. The money which he would pay a building and loan association for such a house complete, together with taxes, insurance, etc., will if saved, together with the labor which any man interested in his own house and capable of handling tools can do, give him a house free and clear in a great deal less time than any borrowing scheme that can be devised. Take my advice; don't buy on the instalment plan, but build little by little as you can. Have the name of living in a shanty for a summer or two; by and by you can stretch your legs in comfort and go fishing, while your neighbor is sweating to pay off his mortgage.

We early made it a rule, taken from William Morris, that we would tolerate nothing on the place that was neither beautiful nor useful. We have had to stretch the rule a few times, as witness the little Entropies, but we have hope that there may be a change in the future. But in general we buy nothing merely because we are afraid of what our neighbors will think. We go in debt not at all beyond our monthly expectation of income. If one year we prefer to spend our money at the mountains instead of on the house, we can. Our house simply stands still; no interest or instalments to pay. We always feel that whatever we really want most we can have because there is nothing that must be paid for first before we can begin something new. Simple life, or strenuous life, either, or a compromise we can try, as our moods or health demand.

Someone will say that all work and no play makes Jack a dull boy. Well I have taken my full share of pleasures, and the greatest of all has been to push the house along. Work to me is the doing of something which I would not do at that particular time if I were not obliged to. Recreation is doing something which I wish to do at the time when I wish to do it. When I found the first year's roofing paper had rotted, and I shingled one side of the roof in a cold drizzly storm, it was work. When it cleared off bright and I finished the other side at my leisure it was recreation. It is not recreation to go home from the office where you have been figuring accounts all day and try to study the use of logarithms. It is recreation to go home from lathe and planer and fit a window—if you want the window in your own house. ENTROPY.

One American company sold 208,000,000 pounds of brass in 1905.

Cutting a Long Square Thread Screw Without a Lathe or a Die.

Some years ago I was mechanical genius in a repair shop connected with a *saladero* (packing house) in the Argentine Republic.

There were very few tools, an old chain planer, a British "sliding and surfacing" lathe that sometimes refused to slide and was never known to surface. It was remarkable how we managed to get out the work at all, but if it had not been for the generous size of our scrap heap, and the almost inexhaustible variety found therein, we would many times have been compelled to throw up the sponge, I am sure.

Whenever there was a break down at any of the *Estancias* (estates) within a radius of 20 leagues, the broken piece, if not too heavy, was shipped to us, or if too large, a very polite letter was sent asking me to come and look the work over and get the machine running. As I was always well paid, and well treated, I rather liked these outside jobs.

One day a note came asking me to go and fix an alfalfa baling press. A ride of 30 miles brought me to the estate where I found the press which was much the same as those used for baling other goods. It had two large screws, one on either side, threaded right and left hand. A heavy yoke with nuts working on these screws pressed the alfalfa together, while the wires were put around the bale. The screw with the left-hand thread was intact, but the one with the right-hand thread was stripped for about 18 inches just in the center, where most of the work was done.

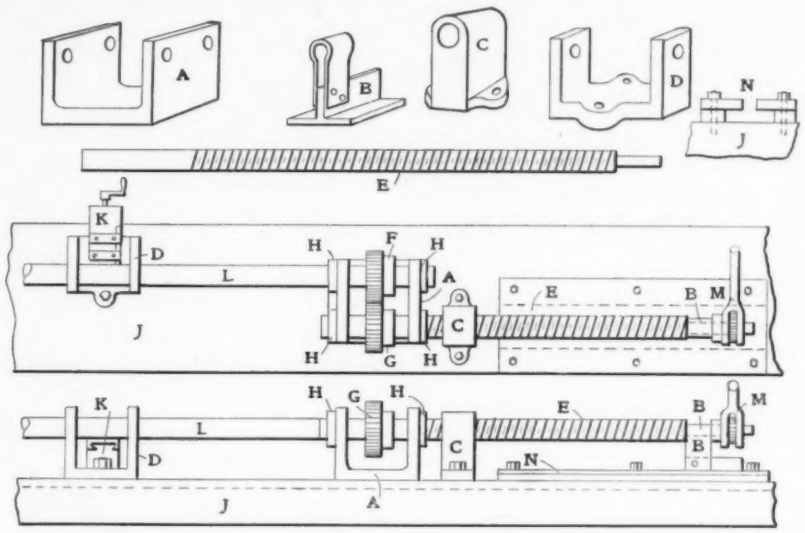
The screws were about 10 feet long, with about 8 feet of thread; they were about 2½ inches diameter, and ½ inch pitch.

As there were no tools of any sort at the estate, I lashed the screws and nuts to a pack horse, and started for home. The journey home was of course leisurely, owing to the pack horse, but I used every minute of the time trying to think of a way to cut that screw. By the time I reached the shop I had settled the job, providing the scrap heap did not fail me, and subsequent events proved that "it seen its duty and it done it noble."

I first got out a piece of 2¾-inch machine steel, and set my only machinist to work turning it for the new screw. I then went to the scrap heap and got a large cast-iron channel iron; from this I cut two pieces; one of these pieces is shown at *A*, the other at *D*. The pieces *A* and *D* were planed on the ends and bottom, then the holes in *A* were bored a snug working fit for the two screws, *E* and *L*. The holes in *A* were spaced so that the two gears *F* and *G* were in proper mesh with each other. These two gears were of course of equal size, and were found in the inexhaustible scrap heap; all

they needed was boring to fit the screws. *B* was made of a piece of T iron with a piece of flat iron bent and riveted to it; it steadied the end of the screw *E* close to the ratchet *M* and the bottom part of it slid in between a track *N* made of flat iron.

The nut *C* was also an old piece from the scrap heap; the nut was run with babbitt. The collars *H* happened to be in



THE JOB AND THE ACCESSORIES.

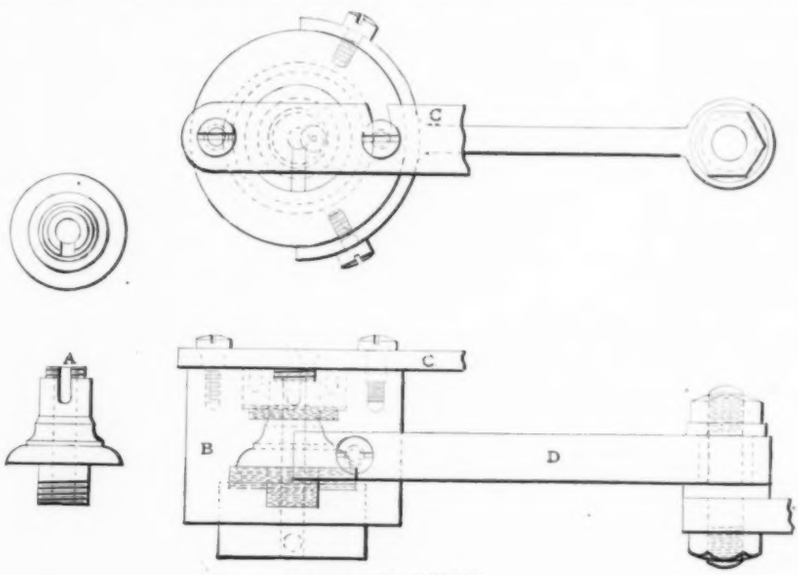
stock. The whole aggregation of scrap was bolted to a large channel iron *J*. The tool was held in a slide rest *K*, taken from a small lathe. After two or three passes with the ratchet, I was satisfied, that while the method was all right, that it was too slow, so I removed the splined rod from the "sliding and surfacing" lathe, mounted it between two hangers bolted to the floor and fitted a pulley with a feather to it. The end of the splined rod was secured to the end of the left-hand screw *E*. The pulley on the splined rod had a slow speed for cutting and a quick reverse for the return. If my memory does not fail me, I cut that right-hand screw in four days; this necessitated setting the nut *C* in two positions, as of course the travel of *E* is less than the length of the thread. The job was quite satisfactory—not a precision screw, but quite good enough for compressing alfalfa. DIXIE.

A Die-Casting Operation.

The drawing shows a tool for die casting the piece *A*. As will be seen the work is threaded at both ends and has a hole clear through to take a stem; it is also slotted at the top end to receive a pin to keep the stem in one position.

The die is made in three parts, of mild steel. The piece *B* is bored out the shape of the work and recessed and threaded at the ends to take two plugs which are bored and internally threaded to fit the piece *A*. The threads in the die are the same pitch as the threaded portions of the job. The top of the die is fitted with a steel strap *C* which is pivoted on a shoulder screw or stud and locked in position with a screw at the opposite side of the die. The die is attached to the arm *D* which is pivoted to a suitable bracket so as to swing the right distance from the melting pot. A handle (not shown) is fitted to the die for convenience in handling. This consists of an iron rod with a file handle at the outer end, screwed into a tapped hole in the side of the die.

The pot is provided with a nozzle which fits over the gate in the flat lever *C* when the die is brought into position for the casting operation. In operating this device the plugs at top and bottom are screwed home tight against the shoulders, the



DIE-CASTING FIXTURE.

fixture is swung under the pot and the metal is forced in. The die is then drawn back clear of the pot, the bottom plug is unscrewed and the lever *C* is pulled around shearing the metal at the gate; by the same movement, the key for the slot is taken out. The top plug is now unscrewed and the casting comes out quite easily.

This method of operating the dies forms a quick way of casting as it brings the tools clear of the pots and saves handling all the pieces separately. A bench can be put in the most suitable position for the operation.

London, England. C. PETITJEAN.

Gas-Engine Governing.

The relative merits of the different methods commonly adopted for governing gas engines were discussed by James Atkinson in a paper on "Gas Engines as Applied to Electric Driving," read before the Manchester Section of the Institution of Electrical Engineers. Of the method which throttles a uniform mixture, Mr. Atkinson states that it is simple and easily arranged, but has the disadvantage that the consumption of gas is extravagant at light loads, while there is then also a large increase of work on the suction stroke, accompanied by low compressions which interfere with prompt ignition of the charge. Moreover, owing to a reversal of the direction of the forces at light loads, there was a tendency to knock.

"Cut-off governing" is satisfactory and can be combined with the "hit-and-miss" arrangement, the former being the method adopted down to half load, while at lesser loads the "hit-and-miss" arrangement is used.

The plan in which the richness of the mixture is varied was stated by Mr. Atkinson to be only occasionally adopted, as the limits of mixture between which the gas would burn properly were relatively small, and hence with such a system improper ignition was frequent.

Stratifying the charge, that is varying the time of ignition of the gas, but always cutting it off at the same time, is a plan of governing which is meeting with in-

creasing favor. It has the advantage of not altering the compression, and with the high compressions now adopted the stratification of the charge does not lead to the same losses as in the older engines, in which the compression was not over 45 pounds per square inch.

Cox's Compressed-Air Computer

The accompanying illustration shows a new and highly useful addition to the list of computers made by William Cox, of 75 Broad street, this city. It is intended to solve problems connected with the power required in compressing air, being made to solve the formula,

$$M.E.P. = 3.463\ P_1 \left[\left(\frac{P_2}{P_1} \right)^{.29} - 1 \right]$$

in which

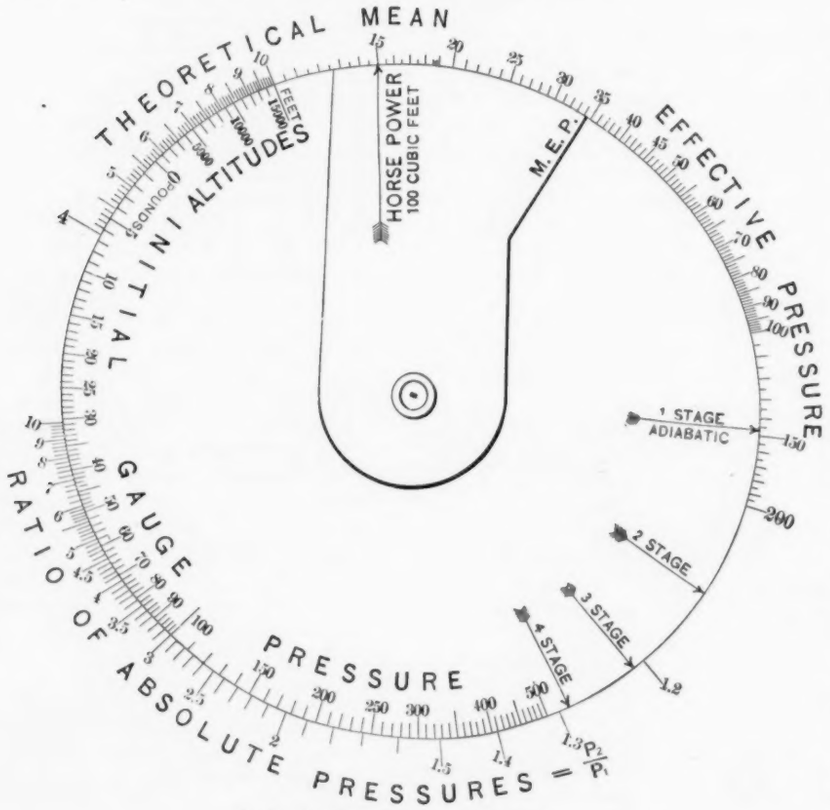
P_1 = initial absolute pressure.

P_2 = final absolute pressure.

Accompanying the instrument is a table of ratios of compression from atmosphere to 2000 pounds, the table giving the ratio for single-stage compression and the ratio for each cylinder for 2-, 3- and 4-stage compression. To find the theoretical mean effective pressure in single-stage compression, it is only necessary to set 0 of the initial gage-pressure scale against the ratio of absolute pressures as found in the table, and then against the 1-stage adiabatic arrow read at once the mean effective pressure. Should the compression be from an initial pressure above atmosphere, that pressure is to be used instead of 0 and should the compressor be located at an altitude, the proper line of the altitude scale is to be used. In compound compression the ratio for the first cylinder as shown in the table is to be used when, against the appropriate arrow, will be found the mean effective pressure of the whole compression reduced to the low-pressure cylinder. The actual mean pressure in the low-pressure cylinder may be found as in single-stage compression from atmosphere, and in the other cylinders by using their initial pressures.

The mean effective pressure found, the horse-power required to compress 100 cubic feet of free air is found by setting the M.E.P. edge of the small sector to the ascertained mean pressure when, against the horse-power arrow, will be found the horse-power required.

Mr. Cox has recently made many additions to his list of computers, which now number over a hundred, and include a great variety of engineering problems. Among recent ones we note computers for belts, paper friction pulleys and testing electrical meters.



COX'S COMPRESSED AIR COMPUTER.

A neat little device used on a gas engine made by the Dudbridge Iron Works (England) in order to enable the ignition spark to be watched in case of trouble with the engine, consists of a plug screwed into the casting and having within it a glass ball or "marble" which forms a strong window through which to look.

The Spiral-Gear Problem Simplified.

BY JOHN EDGAR.

Numerous solutions have been given for the spiral-gear probem, some using complicated formulas, and others ponderous methods of attack through graphics. It is my purpose in this article to give several rules which will appeal to the practical man, to whom there is a feeling of mystery over even the simplest formula, which is not at all to his discredit, since one who does not have constant practice in the use of algebraic quantities is liable to founder on very simple cases. Therefore in this article, I will use plain English in the several rules set forth, and will show their use by a few examples.

I shall use only one term which may lead to an apprehension of difficulty, and this is the term secant, which I shall define as a trigonometrical function, and further explanation is not necessary so far as it applies to the case in hand. In order that the article may be as complete as possible, and to increase its range of usefulness, a table of secants for each degree from 1 to 89 is given.

Since it is usual to cut all spiral gears on a milling machine, the angle referred to in the rules is the angle of the teeth with the axis of the gear, and as most gears are cut with regular gear cutters of diametral pitch, this pitch is used instead of the normal pitch of the tooth as in most previous articles.

If we have the number of teeth, the angle and the pitch of the cutter given, we use rules I, II and III.

Rule I: *To find the circular pitch of the tooth.* Multiply the secant of the angle by 3.1416, and divide the product by the diametral pitch of the cutter.

Rule II: *To find the pitch diameter of the gear.* Divide the secant of the angle by the diametral pitch of the cutter, then multiply the quotient by the required number of teeth.

Rule III: *To find the lead of the spiral.* Subtract the angle in degrees from 90 degrees, divide the secant of the result by the diametral pitch of the cutter and multiply the quotient by 3.1416 times the number of teeth.

Should we have the pitch diameter, the number of teeth and the pitch of the cutter, we use rule IV.

Rule IV: *To find the angle of the spiral.* Multiply the pitch diameter by the diametral pitch of the cutter and then divide this product by the number of teeth. The result is the secant of the angle, and the angle may then be found from the table.

When given the angle, the number of teeth and the pitch diameter of the gear, we use Rule V.

Rule V: *To find the pitch of the cutter.* Multiply the secant of the angle by the number of teeth, then divide the quotient by the pitch diameter.

If we have the pitch diameter, the pitch of the cutter and the angle of the spiral, we use Rule VI.

Rule VI: *To find the number of teeth.* Multiply the pitch diameter by the diametral pitch of the cutter, and divide the result by the secant of the angle.

The outside diameter is figured the same as for spur gears.

Rule VII: *To find outside diameter of Blank.* Add 2 divided by the diametral pitch to the pitch diameter of the gear.

Commercial cutters for cutting spur gears are finished in sets of eight cutters, but owing to the angle at which the cutter is set, it would not be proper to choose the cutter to correspond with the number of teeth in the gear. The number of teeth for which to choose the cutter may be found when we have the number of teeth in the gear and the angle of the spiral given by using Rule VIII.

Rule VIII: *To find number of teeth for which to select cutter.* Multiply the number of teeth in the gear by the cube of the secant of the angle.

The few examples given below will show the use of these rules.

°	SECANT.	°	SECANT.	°	SECANT.	°	SECANT.	°	SECANT.	°	SECANT.
1	1.0001	16	1.0403	31	1.1666	46	1.4395	61	2.0627	76	4.1336
2	1.0006	17	1.0457	32	1.1792	47	1.4663	62	2.1300	77	4.4454
3	1.0014	18	1.0515	33	1.1924	48	1.4945	63	2.2027	78	4.8097
4	1.0024	19	1.0576	34	1.2062	49	1.5242	64	2.2812	79	5.2408
5	1.0038	20	1.0642	35	1.2208	50	1.5557	65	2.3662	80	5.7588
6	1.0055	21	1.0711	36	1.2361	51	1.5890	66	2.4586	81	6.3924
7	1.0075	22	1.0785	37	1.2521	52	1.6243	67	2.5593	82	7.1853
8	1.0098	23	1.0864	38	1.2690	53	1.6616	68	2.6695	83	8.2055
9	1.0125	24	1.0946	39	1.2867	54	1.7013	69	2.7904	84	9.5668
10	1.0154	25	1.1034	40	1.3054	55	1.7434	70	2.9238	85	11.474
11	1.0187	26	1.1126	41	1.3250	56	1.7883	71	3.0715	86	14.335
12	1.0223	27	1.1223	42	1.3456	57	1.8361	72	3.2361	87	19.107
13	1.0263	28	1.1326	43	1.3673	58	1.8871	73	3.4203	88	28.654
14	1.0306	29	1.1433	44	1.3902	59	1.9416	74	3.9279	89	57.299
15	1.0353	30	1.1547	45	1.4142	60	2.0000	75	3.8637		

SECANTS OF ANGLES FROM 1 TO 89 DEGREES.

Example—Let it be required to connect two shafts at right angles to each other by spiral gears having teeth at 45 degrees, to be cut with 8-pitch cutters, and having 16 and 32 teeth in pinion and gear respectively.

Solution: To find the pitch diameter apply Rule II.

Secant of $45° = 1.4142$.

For pinion, $\frac{1.4142}{8} \times 16 = 2.8284$ inches pitch diameter.

For gear, $\frac{1.4142}{8} \times 32 = 5.6568$ inches pitch diameter.

Applying Rule III we find the lead of spiral:

For pinion, $\frac{1.4142}{8} \times 16 \times 3.1416 = 8.87$ inches.

For gear, $\frac{1.4142}{8} \times 32 \times 3.1416 = 17.75$ inches.

Example: What will be the angle of the spiral of a pair of spiral gears connecting two shafts at right angles, the pinion having 15 teeth, the gear 30 teeth cut with 6-pitch cutters? The large gear to be not over 6-inches pitch diameter.

Solution: Using Rule IV, we get for the gear

$$\frac{6 \times 6}{30} = 1.2 = \text{secant of angle } 34°.$$

The sum of the angles in a pair of spiral gears is always equal to the angle between the shafts, therefore we find the angle of the pinion to be

$$90° - 34° = 56°$$

Applying Rule II, we find the diameter thus:

Secant $56° = 1.7882$

$\frac{1.7882}{6} \times 15 = 4.47$ inches pitch diameter.

Example: It is desired to actuate a spur rack by the aid of a spiral gear on a shaft set at an angle of 60 degrees with the side of the rack. The gear to have 30 teeth. The diametral pitch of the rack is 5.

Solution: An inspection of the problem shows what is required is to find the diameter of a gear with 30 teeth and angle of spiral 30 degrees cut with a 5-pitch cutter. We apply Rule II:

Secant $30° = 1.1547$

$\frac{1.1547}{5} \times 30 = 6.9282$ inches pitch diam.

Outside diameter by Rule VII is

6.9282 inches $+ \frac{2}{5} = 7.3282$ inches.

To find lead of spiral apply Rule III.

Example: What cutter would be used to cut the gear in the preceding example?

By Rule VIII we get

$30 \times 1.1547 \times 1.1547 \times 1.1547 = 46.2$ teeth

By referring to a manufacturer's table we find that a No. 3 cutter would be required.

Spiral gearing is the most flexible form of toothed gearing in existence. It is the only form of gearing in which the diameter is not entirely dependent on the number of teeth; that is, a 6-inch gear may have either 10 or 40 teeth of the same pitch, so that in such a case the pinion may be of larger diameter than the gear. This makes it possible, in a great many cases, to change the ratio without changing the sizes of the gears. Spiral gears may only be used to connect shafts whose centers do not intersect at any point.

Sometimes it is hard to obtain gears of the required dimensions for shafts at fixed center distance by calculating, but the preceding method is to figure the gears so that the nearest approximation is obtained. Then if the diameter is not too far out the slight variation is made up by cutting the teeth deeper, or *vice versa*, as the case may require. When the variation is very great, the blank may be rolled, besides being cut deeper, so that a mongrel pitch is obtained.

Spiral gears *can* be figured for a given center distance so as to come exact within very small limits; but the process requires a somewhat complicated formula, and the difference between the doctored gear and the perfect one is so small that the extra work is not warranted.

On account of the smoke and gases discharged by locomotives in the Gallitzin tunnel, of the Pennsylvania Railroad, the atmosphere often became so bad that the trainmen were rendered unconscious. In order to relieve this condition a sheet-iron hood about 50 feet long was constructed enclosing one track and having an inner surface coincident with the soffit of the tunnel arch and walls. A Sturtevant blower was installed at the end of the hood on each side and delivered air to the tunnel. When a train comes up the grade into the tunnel the fan is started and the large volume of air which is forced into the narrow space between the train and the tunnel lining drives the smoke and gas in advance of the locomotive so that the crew can keep the cab windows open and they are supplied with an abundance of fresh pure air.

It seems to us that those who are seeking for a uniform torque in a gasolene engine ought to be satisfied by the Antoinette engine, which has 16 cylinders, 8 pairs at right angles, there being 8 cranks, one to each pair. Each cylinder has its own carbureter and is water-cooled. Aluminum plays an important part in the construction; the weight per horse-power is only about 2.2 lb., making it very suitable for aëronautical purposes. 16 cylinders! To build one of these engines is quite a manufacturing job.

Some idea of the volume of the telephone business done in New York may be gathered from the fact that the latest edition of the telephone directory filled 25 railway freight cars and weighed 400 tons. Three hundred and sixty-five thousand of the books were distributed. As a new issue of this directory is distributed every four months, it has become by far the most generally used directory of New York and vicinity.

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An Injury to All American Business.

An English correspondent writes apropos of our article at page 756: "I have read your article on 'An Injury to All American Business' with great interest and think perhaps you have exaggerated the impression which recent insurance and meat-packing scandals have made in this country. In all probability both lines will suffer temporarily; but I do not think anyone over here would find fault with the condition of your engineering trade, or the quality of your machinery, and your market in future should be just as good as it has been in the past.

"Apropos of the same subject, I think perhaps it might be worth while to call attention to an act of individual bad faith which, as it may get widely known, will certainly disturb confidence in commercial relations between your countrymen and ours. A certain man from Chicago, who was employed by the Roc Steel Castings Company, West Drayton, Middlesex, to set going some of his patent furnaces, saw fit on his return to America to write a letter to one of the English engineering papers, with the apparent intention of injuring those who had employed him. He endeavored to make out that the material manufactured by this company was not what it claimed to be.

"I leave this latter question aside, as the company is well able to look after itself; but what I do think a matter of importance is that some protest should be made against an act of conspicuous bad faith. It is not an act which can be reached by any criminal or civil action, but it is none the less one which we over here would abhor. Whatever quarrel this man may have had with the company who employed him, nothing in our eyes would justify him in thus turning against people who had employed him as special and confidential expert for a certain purpose.

"I only suggest your inserting this paragraph of mine, if you should consider that it is a matter which may have some slight bearing on the subject with which you recently dealt."

The communication referred to stated that no steel castings were made in the furnaces of the Roc company, this assumption being based upon the fact that nothing but malleable castings were made in them immediately after their erection under the direction of the Chicago man, and during the sixty days thereafter when he had charge of them.

Needless to say, this was pure assumption, and we are surprised that the English engineering journal should have published such a statement without very careful investigation of the facts of the case. If the act of bad faith by the Chicago man can be fairly charged up against Americans, what can be said about the manifest impropriety involved in the publication of his communication in the columns of an English engineering journal? We know of no American journal of any standing which would think of publishing such a thing without first carefully investigating.

No Rigid Materials—Fortunately.

There is no such thing as an absolutely rigid structure, and there does not exist anywhere in the world material of which to build one. Possibly it would be extremely difficult to find a use for such a material if it could be procured, but this is a subject upon which doctors differ. In an address delivered by a gentleman of high scientific attainments, the opinion was advanced that a perfectly rigid beam would support a load of infinite amount, for the reason that no matter how great the weight imposed upon it, nor from how great a hight it was permitted to fall, there could result no deflection of the beam, and consequently no work would be done within its molecular structure, and it could not possibly fail. On the other hand, it is argued by others of equal standing in the scientific world that, supposing a perfectly rigid beam to exist, the smallest imaginable weight falling from the least possible distance would deliver its entire energy upon an infinitely minute portion of the beam, and there cause a slight rupture which, on account of the absolute rigidity of the material, could not fail to spread entirely through the beam.

When leading lights shine thus differently, the question is not illuminated so clearly as to enable the rest of us to feel sure about these things. However, as the subject, by its very conditions, is removed from the bounds of the possible, it is, perhaps, about as useful a topic of discussion as the speculation of certain Hindoo philosophers which it would seem the world could get along just as well without. Starting with impossible premises, it is extremely likely that a variety of sufficiently logical and equally impossible conclusions may be drawn.

Fortunately, in engineering practice we do not deal with substances of any kind possessing these imaginary qualities, and therefore human effort, with its necessarily imperfect results, is not out of keeping with the material upon which, and by means of which it must make itself manifest. The elasticity of the members of a framed structure must be depended upon to make up for the inevitable inaccuracies of finite workmanship. Were it not for some slight yielding, this way and that among the different members of a bridge, there would be no possibility of constructing them so accurately that each would take its share of the load, or even that some of them would not be relieved of any part of it with a consequent overstress upon others, leading to the failure of the whole construction.

It is much the same with regard to wear upon the moving parts of machinery.

Greatly as we may regret the fact that materials wear away in service, and that we are compelled to design with liberal surfaces to compensate for this inherent quality of inanimate matter, men have seldom been able to construct a machine so finely adjusted at the start that its action was as perfect as after its parts had worn themselves into greater harmony in their relations with each other. This wearing together is at times very slight; at others it is more pronounced, even to the extreme of placing fine sand upon the teeth of mating gears to hasten the time at which they will have worn into shapes of closer agreement with those against which they work than was given them by the imperfect methods of their manufacture.

Instruments of precision, which usually are most nearly perfect in adjustment when leaving the hands of the maker, are an exception to this rule more apparent than real, as their nicety of adjustment is brought about by a process of coaxing and wearing of the various parts very similar to that which occurs in use with machinery of a less highly finished character.

So long as our manual skill is limited by its present character of imperfections, we need entertain but little regret that we have not a perfect material; perfect, that is, in the sense of being perfectly rigid or perfectly elastic; perfectly hard or perfectly soft, if such an anomaly could be imagined; nor yet one perfectly smooth, any more than its converse and still more glaring impossibility, one that is perfectly rough.

Conditions in Indian Cotton Mills.

How modern improvements may sometimes fail to benefit or may even injure certain classes of people, is shown by a recently published report of our consul, William T. Fee, writing from Bombay of the cotton-mill industries there. He says that in 1881 an act was passed by the Government of India, one of the chief features of which was the compulsory closure of all factories for at least four days in a month. This move was much appreciated by the workmen, owing to the respite afforded to them from their tedious and irksome work which it would seem had been without intermission. "But," he writes, "a new factor has been recently introduced in the shape of electric light installation in the textile factories, which has resulted in practically nullifying this benefit. Since the introduction of this light the mills, which formerly used to work from sunrise to sunset, have begun working from five in the morning to eight in the evening, with the same set of operators, and with only half-an-hour's stoppage in the middle of the day." Regarding this condition of affairs Bomanji Dinshaw Petit, an extensive employer of mill labor, says: "It is as clear as daylight that these unfortunate people must suffer in physique, that their crushing work must produce its deleterious effect upon their health, that their resisting capacity must gradually dwindle down, and that day by day they must grow more impotent to resist attacks of ill health and the prevalent epidemics, if they are not actually slowly ground to death. I deliberately assert that every additional pound of production got by making them work longer than 12 hours a day is wrung out of their aching limbs." And this respected gentleman further declares that "the conditions of labor in the Bombay mills at present reveal a degrading and disgraceful spectacle of cold-blooded inhumanity."

It is England's boast that slavery has been abolished within her dominions. It would seem, however, that if these Hindu cotton-mill operatives were slaves they would be better off, since their owners would then at least have some pecuniary interest in so treating them as to preserve their health and strength for a reasonable length of time.

The School for Instrument Makers at the University of Leyden.

An interesting paper on the above subject was read at the recent Boston meeting of the Eastern Association of Physics Teachers by F. M. Gilley. The school has developed to meet the need for instrument makers to prepare instruments for experimental work, and began with a gun maker, whose duties were originally the care and preparation of instruments for laboratory and lecture-room work, and gradually extended to the repair of these instruments and ultimately to the making of new ones as required.

The school now turns out expert instrument makers and assistants to university teachers of physics, for whom there is said to be a constant demand. The students come from the trade schools of Holland, the selections being made by examinations that are, in effect, competitive, but ten students being selected at a time from long lists of applicants.

Eleven hours a day are given to work—eight hours to practical, and three to theoretical work. The subjects of instruction include glass blowing, mechanical- and physical-instrument making, electro-technical work, drawing, forging for scientific and medical instruments, and the arrangement of apparatus for lecture and laboratory experiments. The entire course occupies three years.

The organizer of the school is Dr. H. Kamerlinch Onnes, director of the physical laboratory of the university, who, without help or reports from committees or commissions, has recognized a growing need and organized a highly successful school to meet it.

Now it is Ireland that will have an international exposition—Dublin, in 1907.

New Publications.

"Outlines of the Evolution of Weights and Measures and the Metric System." By William Hallock, Ph.D., and Herbert T. Wade. 304 6x9-inch pages; cloth, $2.25. The Macmillan Company, New York.

The authors, the first mentioned of whom is professor of physics in Columbia University, New York, and the second, editor for physics and applied science of the "New International Encyclopedia," avow themselves as in favor of the metric system on the ground of its intrinsic superiority, and the manifest advantage of having, if possible, one system of weights and measures in all industries, and throughout all the world. They have, however, as they state, "aimed to avoid as far as possible all controversy for several reasons; the first and most important of which is, that this side of the question has been and is being abundantly covered elsewhere, so that it has seemed preferable in this work to include a mere statement of facts rather than to repeat or even add to arguments." They have, however, given a fair and concise history of the metric system so that its logical development and characteristics will be apparent, and this, together with the experience of European nations as briefly given, ought to help anyone who wishes to form an intelligent opinion as to the desirability of adopting the system here, and in Great Britain. Regardless of one's opinion as to whether or not this is possible or practicable, the book will be found interesting, both in its treatment of the historical side of the development of weights and measures, and in its account of the "state of the art" as it exists at the present time. Great pains have evidently been taken to have the statements in the book agree precisely with the facts; there is a voluminous citation of authorities and of references to the bibliography of the subject, and there are good and convenient tables of equivalents and a good index, so that as a work of reference on the subject it will be found to be scholarly and of great usefulness. It is to be regretted perhaps that the only references to the literature of the subject as found in the transactions of the American Society of Mechanical Engineers fail to indicate that there is in those transactions anything else than arguments against the metric system, the fact being that there is something on the other side as well.

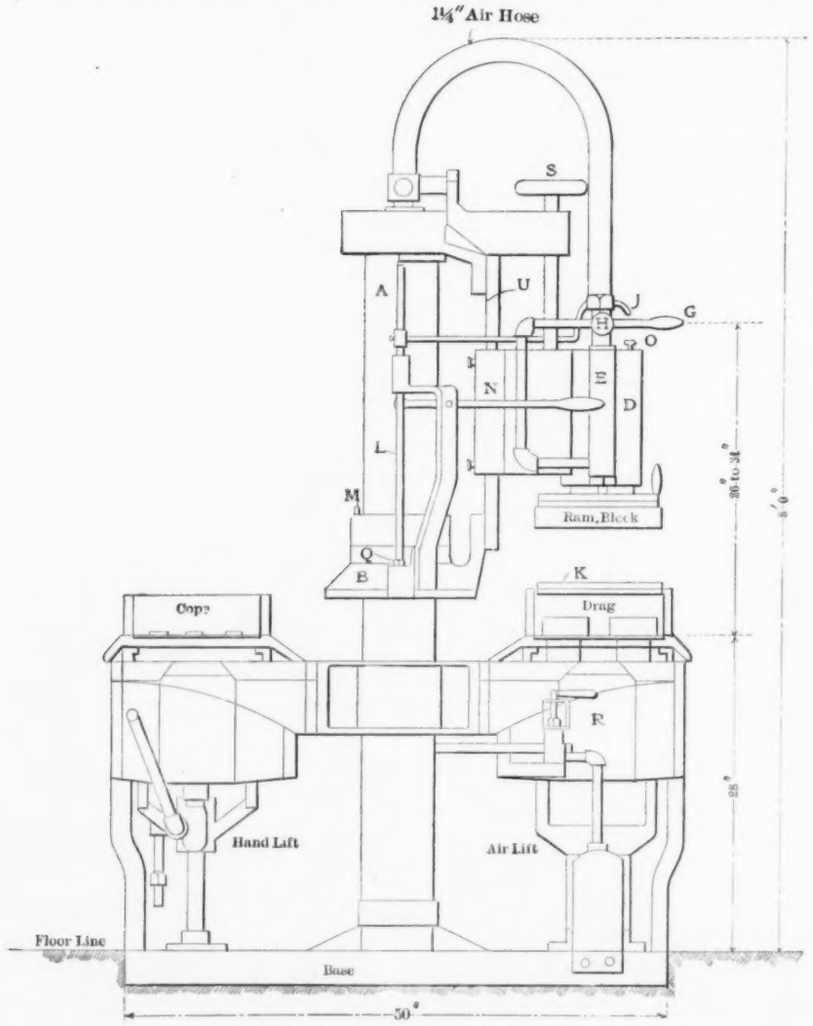
The Western Gas Engine Company, of Los Angeles, sends us a copy of the de luxe edition of "Southern California," which was gotten out in honor of the Los Angeles fiesta, and which gives a very good idea of the attractions of that most magnificent country.

The speed of the United States gasolene torpedo is 36 knots.

New Tools and Machine Shop Appliances.

THE PAXSON-HALL MOLDING MACHINE.

The Paxson-Hall molding machine, of which an elevation is presented herewith, is a downward air-ramming machine with swinging ramming head, which may be brought over any of the molding tables; the latter may be of two different types and in number up to four. The machine is so made that it may be bought in sections and put together as suits the convenience of the purchaser. Thus, if he intend to put one in, he can buy the machine with a hand-lever drawing table and without the ramming head, and do his ramming by hand; or, suppose that he has already installed hand-rammed machines of the "low-down" type, and that he now has air power, these machines can be placed on the foundation plate of the new machine, which, this time, is provided with the power-ramming head, thus giving the combination of stripping-plate machines and an air rammer.



THE PAXSON-HALL MOLDING MACHINE.

The machine consists of a column *A* supported upon a base and having attached to it tables, usually two in number, one for the cope and one for the nowel. The table shown to the left in the illustration and marked "hand lift" is of the drop pattern type, where the pattern is lowered by means of a lever at the side of the machine; this type takes in such work as does the Pridmore machine. The other type of table, shown on the right and marked "air lift" is what is called a "split pattern" machine, where the pattern remains stationary on a pattern plate while the stools or stripper are caused to rise upward with the flask frame, flask and sand, by means of air power, controlled by the three-way valve *R* at the side of the machine, which valve also controls a rapping device. *K* is the bottom board in place on the drag flask.

One ramming cylinder *D*, which can be revolved completely around the column *A*, serves for all the tables which may be attached to the column. Within the casting *B* are ball bearings which are oiled through the small oiler *M*. *Q* is the locking pin which falls into holes properly located so as to bring the ramming cylinder in direct line with the different tables. *U* is a vertical guide to which the cylinder *D* is made fast by six set-screws. The cylinder is adjustable up and down to accommodate different depths of flask, by means of the screw and hand wheel *S*. Although 2 inches motion of the plunger is sufficient for ramming the mold, it is capable of 7 inches stroke: this permits of a difference of as much as 5 inches between the hights of the cope flask and the nowel, without having to change the vertical adjustment of the ramming head between the two operations. The air is led from the hollow central column to the throttle-valve by the 1¼-inch hose shown in a bend above the machine. By means of the throttle-valve the plunger can be caused either to strike a heavy blow or simply to squeeze the mold. Alongside of the ramming cylinder *D* are two small cylinders *E*, which return the plunger after it has done the squeezing.

The safety device which prevents the ramming plate being brought down except when the cylinder is locked in line with a table, is arranged as follows:

H is the throttle-valve controlling the admission of air to the ramming cylinder, and *G* is its hand lever; *L* is a rod which slides up and down with the locking pin *Q*, and *N* is a hand lever which operates it. To *L* is connected another lever with a hooked end *J*; the fulcrum of this lever is concealed behind the air pipe leading to the lower end of the cylinder *E*. A downward motion of the handle end of the lever *N* raises the rod *L* and the locking pin *Q*, and at the same time lowers the finger *J* close to the throttle lever *G*, so as to make it impossible to turn the latter to open the throttle. When the locking pin drops into place again, the finger *J* goes up and the throttle lever *G* is no longer blocked. Oil is put into the cylinder *D* through the oil hole *O*.

The machine weighs approximately 2800 pounds and occupies a floor space 24 by 60 inches. It is made by the J. W. Paxson Company, Philadelphia, Pa.

A NEW WAY OF USING A POWER HACK SAW.

The Hoefer Manufacturing Company, Freeport, Ill., has recently received the following letter, describing a new way of utilizing one of its power hack saws.

"A short time ago we had occasion to cut a head off a steel casting for a crank shaft, and our lathes being busy, we did not care to take the time necessary to do it.

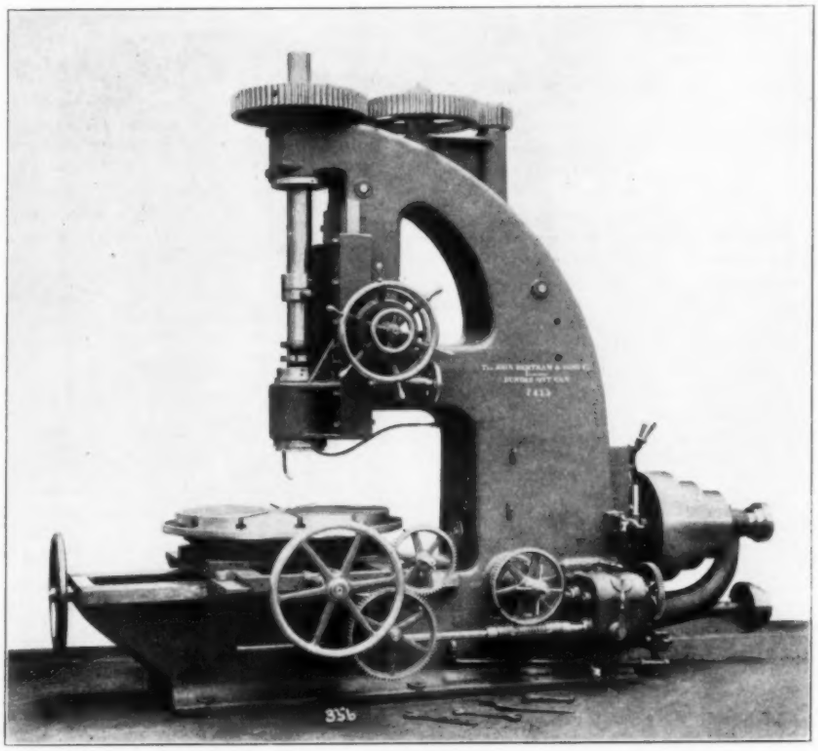
"We had a frame made for the saw blade so that we could use 18-inch saws. We then turned the saw frame around, so that it extended over the back of the machine, moved the saw up to the steel forging, and drove it from the line shaft. The shaft is 11½ inches in diameter at the part where it was cut, and took 20 hours to saw through. But inasmuch as we were in no particular hurry, the time did not signify. We cut half way and then turned the shaft upside down, and cut through

from the opposite side. Two saw blades were used in the operation."

"We figure that we have saved the cost of the saw—which was purchased from you about three years ago—on this one operation."

HEAVY VERTICAL MILLING MACHINE.

The accompanying illustration shows a new design of heavy vertical spindle milling machine by the Bertram Works, Dundas, Ontario, of the Niles-Bement-Pond Company. The table is fitted with the movements and adjustments that are usual on slotting machines—that is longitudinal, cross and rotary, the feeds being under the control of a gear box as shown. The lower end of the spindle is supported by a slide having both fine adjustment and quick traverse by hand, the sliding bearing and spindle being balanced by a counterweight inside the frame. The table is surrounded by an oil channel and the machine is fitted with an oil reservoir and pump. The table is 42 inches in diameter and has 36 inches longitudinal and 32 inches cross movement. The spindle is 5



HEAVY VERTICAL MILLING MACHINE.

inches in diameter and has 21 inches vertical adjustment. The distance from the center of the spindle to the frame is 32½ inches.

BLACK DIAMOND TURNING POINTS.

In the accompanying line engravings are represented a number of tools with carbon (black diamond) points for turning materials of a hard, tough or gritty nature. These tools are all of special form—that is, each point is shaped expressly for some particular class of work, some being adapted to turning fiber, others to machining celluloid, hard rubber, paper and cotton rolls, chilled iron, hardened steel, brass, etc. As some of our readers are aware, such tools have been used for years in truing up paper-mill rolls, and more recently they have come into service for machining interchangeable parts, such as fiber disks for water

BLACK DIAMOND TURNING POINTS.

meters, fountain-pen barrels and similar pieces of hard rubber, and brass and tough metal work handled in the engine or turret lathe. In fact, they are adapted to any class of turning where, owing to the nature of the material, steel tools cannot be relied upon to hold their edges for any length of time. The points are set in round steel bodies and these in turn are secured in regular steel shanks of the standard sections for lathe tools, or they may be inserted in special holders of any desired form to suit the requirements of the work and the machine in which it is handled. In turning fiber, hard rubber and celluloid with these carbon points the work is run at a high rate of speed and roughing cuts of considerable depth may be taken, the feed per turn naturally being quite fine; the finishing cut is of course quite light, as is also the case when working metal, which, like the other materials mentioned, is run at high velocity during the machining operations. The points are used indefinitely before becoming dull. When they finally lose the keen edge they are returned to the maker to be put into shape again. One point seen recently had been in operation in a turret lathe, machining brass pieces for many months before losing its keenness sufficiently to require sharpening. The carbon points thus not only enable a job, say in a lathe or screw machine, to be held to size day after day without readjustment of finishing tools, but also come into service in boring out cylinders and doing similar lathe work where a steel tool is likely to lose the size before the finishing cut is completed. It should be stated that neither the points nor the steel shanks in which they are set are shown to scale in the engraving. The diamond in each instance is selected and shaped to the requirements of the case, and the steel holder is simply finished to a size suited to the point to be held. The maker is Thos. L. Dickinson, 45 Vesey street, New York City.

The editor of our British contemporary, *The Builder* evidently prefers to depend upon *Punch* for his humorous reading, and to have rigidly excluded from all technical writing anything which he may imagine approaches levity, for he begins a review of a new book on pattern making as follows:

"If we omit from consideration some American and one or two English papers, it may safely be said that the technical press of the world is conducted on serious lines, and is fairly free from the writings of misguided people who try to make science and art interesting by treating technical subjects in a way that is meant to be funny. Judging from his colloquial style and the statement that some of the subjects discussed in this treatise have appeared in the AMERICAN MACHINIST and the *Pattern-Maker*, we assume Mr. Barrows to be either an American, or an Englishman who has lived for some time in the United States."

Some of the funniest things we have ever seen in technical journals were not intended to be funny, and were not published in the United States.

Personal.

A. T. Anderson, the new secretary-treasurer of the National Supply and Machinery Dealers' Association, whose offices are at 69 to 71 Frankfort street, Cleveland, Ohio, is making a special effort to increase the membership of the association named, and is at present sending to machinery and supply dealers all over the country some specially prepared statements of the reasons why those engaged in that line of business should belong to the association.

Not long ago in one of the shops of the National Tube Company, where it became

necessary to do some lathe work on the crank shaft and disk of a 24x28-inch Porter-Allen engine which weighed 10 tons, no lathe was available for the work, and it was done in a rather curious and interesting manner. The spindle and outboard bearings of a Fosdick No. 2 horizontal drilling, boring and milling machine were fitted with centers, and the spindle with a suitable driver. The crank shaft was then mounted upon these centers, which were raised to a sufficient hight for the swing required. Upon the bed of the machine a portable slotting machine was then placed, thus affording a means of holding the necessary turning tools and for giving them the lateral and cross feed motions required to do the work. In this case the combined weight of the two machines used in doing the work was probably just about equal to the weight of the piece of work itself. Mr. Wall, who was the operator in this case, photographed the crank in place upon the machine and sent the photograph to the Fosdick Company. If the photograph had been nearly as good as the work, we could have reproduced it, but it was so dim as to make its use for half-tone purposes impossible.

Business Items.

The Stanley-G. I. Electric Manufacturing Company has opened a sales office, under management of C. A. Mann, at 822 New York Life Building, Omaha, Nebraska.

A. J. Vance, who has recently taken up the Buffalo Forge Company and the Buffalo Steam Pump Company's interests in Cincinnati, is located at 403 Neave Building.

The Sprague Electric Company has reopened its office in San Francisco. The former office was destroyed by the earthquake, after which temporary quarters were opened in Oakland. They are now permanently located in the Atlas Building on Mission street, San Francisco.

The works of Brown & Sharpe, Providence, R. I., will be closed from August 3 to 13, inclusive, for the annual vacation and repairs. During the vacation the offices will be open as usual and orders for machine tools, machinists' tools and measuring tools will receive the same attention as at other periods of the year.

The Woburn Gear Works, Woburn, Mass., have just equipped a factory at 32 Nashua street and have installed the latest machinery for cutting gears, racks, pinion wire, etc., making a specialty of small and medium work; also machine chain and bearings. The business is carried on and owned by Herbert A. Warren, Edwin H. Warren and Ernest C. Warren as partners.

The Foos Gas Engine Company, Springfield, Ohio, has just placed an order for $20,000 worth of machine tools, consisting of lathes, planers, boring mills, drill presses, grinders, etc. Their business so far this year shows an increase of 50 per cent. over any previous year, and this extra equipment will enable them to make prompt delivery of all orders.

The Wm. J. Smith Company, New Haven, Conn., has been incorporated under the laws of the State of Delaware. It will manufacture adjustable reamers, automatic tools and special machinery. The offices and works are located at 424 State street. Wm. J. Smith, the general manager, is well known in the machinery field and was formerly superintendent for the Geometric Tool Company, New Haven.

Pursuant to their regular custom, the factory of H. H. Franklin Manufacturing Company, Syracuse, N. Y., will be closed for annual inventory and repairs during the last two weeks of August, and they suggest that if any of their customers expect to need castings during that time that they will favor them with their orders as early as possible to enable them to get them out before August 18. The factory will start up again Tuesday, September 4.

Manufacturers.

Van Ness Bros., box manufacturers, Paterson, N. J., will build a new mill.

The Ohio Foundry Company, Cleveland, O., will erect a new $22,000 foundry.

The Bemis Bros. Bag Company, San Francisco, Cal., will put up a new $25,000 factory.

Enz & Orr, Denver, Colo., will erect a modern foundry and machine shop at a cost of $20,000.

The American Wringer Company, Woonsocket, R. I., will erect a factory near Milwaukee, Wis.

Dr. Frank Lake, of Guadalajara, Mexico, has been granted a concession to establish an automobile factory there.

The Foster Bros. Manufacturing Company, Utica, N. Y., has decided to rebuild its iron-bed factory, recently burned.

The Prescott Company, Menominee, Mich., sawmill and mining machinery, is erecting an addition to its machine shop.

The Meriden (Conn.) Firearms Company, which has just completed an addition, is planning the erection of another.

The Eastman Kodak Company, Rochester, N. Y., is to build another large addition for general manufacturing purposes.

The city of Marquette, Mich., is planning to erect a new $60,000 electric-power plant, the present one being overtaxed.

The Modern Bedstead Factory Company, Sherbrooke, Que., will establish an iron and brass bed factory in Cornwall, Ont.

The Reinhart Mitten Company, Milwaukee, Wis., has purchased a factory building, which will be remodeled and equipped with knitting machinery.

The Farley & Mitchell Company, of Dubuque, Iowa, manufacturing sashes, doors, blinds, etc., will erect a factory in Sioux Falls, S. D.

Sharon and Erie steel men will erect a blast furnace at Erie, Pa., to cost about $500,000. Alfred Perkins, formerly treasurer of the Sharon Steel Hoop Company, is interested.

The Nadeau Kaolin Putty Company is being incorporated with a capital of $1,000,000. T. Nadeau, of Lebanon, N. H., will be president and general manager, and plants will be erected in Boston and Cincinnati.

The Colorado Gray Iron Foundry Company, Denver, Colo., a new concern, has taken out a permit for the erection of a plant. J. M. Herbert, formerly of the Colorado & Southern Railroad, is president.

A plant for the American Telegraphone Company is being erected at Wheeling, W. Va. The financing of this undertaking is in the hands of Chas. K. Fankhauser & Co. and the Sterling Debenture Corporation, of New York.

The Standard Metal Work Company, Thompsonville, Conn., a new concern which will manufacture bent pipe, will erect a plant. James A. Colvin, owner of the G. H. Bushnell Press Company, of Thompsonville, is president of the company.

A manufacturing colony, which, it is said, will result in the expenditure of at least $500,000 in buildings, will be established at Oakley, Ohio. The companies interested in the scheme are the Cincinnati Milling Machine Company, Bickford Drill and Tool Company, Triumph Electric Company and the Cincinnati Planer Company, all of Cincinnati, Ohio.

Catalogs.

Buffalo Forge Company, Buffalo, N. Y. Catalog describing Buffalo air washer and humidifier. Illustrated, 36 pages, 6x9 inches.

E. W Bliss Company, Brooklyn, N. Y. List No. 12. Second-hand metal-working machinery. 60 pages, 5x7½ inches.

Witte Iron Works, Kansas City, Mo. Catalog of gas, gasolene, naphtha and distillate engines. Illustrated, 40 pages, 6x9 inches.

The F. B. McCrosky Manufacturing Company, Meadville, Pa. Catalog and price list of reamers. Illustrated, 15 pages, 3½x6 inches.

Wiley & Russell Manufacturing Company, Greenfield, Mass. Catalog of lightning machine relieved taps. Illustrated, 24 pages, 3½x5½ inches.

Bateman's Machine Tool Company, Ltd., Balm Road, Hunslet, Leeds, England. Catalog of high-speed planers. Illustrated, 25 pages, 7x9 inches.

Rockwell Engineering Company, 26 Cortlandt St., New York. Catalog F, describing fuel-oil burning appliances. Illustrated, 18 pages, 6x9 inches.

Robert C. Smith Company, 929 Monadnock Block, Chicago, Ill. Catalog describing the Smith system of water softening and purification. Illustrated, 6 pages, 6x9 inches.

Ingersoll-Rand Company, 11 Broadway, New York. Catalog No. 383, describing the Temple-Ingersoll electric air rock drill. Illustrated, 40 pages, 6x9 inches.

De La Vergne Machine Company, foot East 138th St., New York. Folder No. 8013, illustrating and describing the Koerting four-cycle gas engine and suction gas producer.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Agents to sell all kinds of counting machines. R. A. Hart, Battle Creek, Mich.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Automatic machines designed and built. Geo. M. Mayer, M. E., 1131 Monadnock Bl., Chicago, Ill.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Wanted—Will pay 50 cents for AMERICAN MACHINIST of March 22, 1906. Address Box 806, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—9 or 11-inch engine lathe, 4 or 5-ft. bed, for general repair work. Address *Evening Leader*, New Haven, Conn.

Wanted — Work for an 84-inch Bickford boring mill; can furnish castings. Fulton Machine & Vise Co., Lowville, N. Y.

Wanted—A second-hand testing machine, 50,000 to 100,000 tensile strain. Watson-Stillman Company, 26 Cortlandt St., New York City.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Offers, with catalog, desired for machinery, wanted for complete bolt, nut and rivet plants. Reply to Box 777 Root, 200 Greene street, New York.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Wanted—Correspondence from a firm or individual desiring the rights to manufacture and handle a small metal novelty. Box 818, AMERICAN MACHINIST.

We have a modern machine-shop equipment and are prepared to design and build to order high grade special machinery and tools. Cummings Machine Co., 182 William st., New York.

Wanted—Address of manufacturer of razor-blade grinding machinery and figures on 50,000 order to be honed and ground. Address F. M. Lawrence, 11 East 24th St., New York City.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Well known and old-established firm in Birmingham, England, doing business with all the large engineering works, is anxious to take up the sole agency for some specialty worth pushing. Highest references given. Box 780, AMERICAN MACHINIST.

Gas-engine builder, American, age 36, thoroughly practical, 15 years' experience, solicits correspondence with manufacturing company contemplating manufacturing gas engines for automobiles, railways, mines, or stationary. Address Box 788, AMERICAN MACHINIST.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/3 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Company, 1036 Majestic Bdg., Detroit, Mich.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Excellent machine-shop building, with power, in Philadelphia; 60x90 feet, three stories, solid ground floor. Box 545, AM. M.

For Sale—One 50-h.p. gasolene engine, used only a few months and good as new; also one 25 h.p. Address Detroit Engineering Works, Chene and Guoin streets, Detroit, Mich.

For Sale—Foundry, machine and boiler shop, well equipped and in operation, in one of the best growing towns of Oregon; good opportunity for a competent manager of limited means to acquire a substantial interest. Box 761, AMERICAN MACHINIST.

For Sale—3-motor electric crane, Northern Engineering Co., 32 feet 3-inch span; first-class condition, with rails and run-way shed 192 feet long and wiring complete. Capacity, five tons; will handle eight tons. Price, traveler, $1500; run-way and wiring, $500; wooden shed, $300. Can be seen operating. Edwin Shuttleworth Co., 105th St. and East River, New York City.

For Sale—Controlling interest, or all, of a profitable, well-established manufacturing business located at Pittsburg. As plant investment is small, business can be moved to suit purchaser. Manufacturing and sales organization can be retained if desired. Capital required, $25,000 to $50,000. For further information address John J. Fitzgerald, Room 1508, Park Building, Pittsburg.

Business Opportunities.

Wanted—Good concern to make direct-reading gas-meter index and buy part interest in same. Address Box 799, AMER. MACH.

A company manufacturing a machine which has been sold to, and accepted by, the U. S. Government, and which has no effective competition to meet in this and other important markets, desires to increase its capital by interesting someone who believes in what is known as industrial betterment. Answers are requested from principals only. Address "Betterment," care American Institute of Social Service, 287 Fourth avenue, New York.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Position as general foreman or superintendent; first-class machinist and toolmaker, understand drafting; age 35; best of references. Box 811, AMERICAN MACHINIST.

Practical mechanic desires change; wants position as superintendent or master mechanic; has wide experience in getting up new tools and labor-saving devices for the manufacturing of interchangeable machinery; thoroughly conversant with handling men and machine tools; familiar with piece work and premium system. Box 809, AMER. MACHINIST.

MASSACHUSETTS.

Expert planer hand desires position as foreman of planers; experienced; would operate in small shop; hustler. Box 812, AM. MACH.

Technical graduate with 10 years' shop experience desires a beginner's position in a drawing room, with chance for advancement; have natural inventive ability. Box 790, AMERICAN MACHINIST.

NEW YORK.

Machinist, 12 years on experimental work, fine milling a specialty, desires change of location. Box 800, AMERICAN MACHINIST.

Mechanical draftsman, three years' experience, two years' shop experience, desires position in New York City or vicinity. Box 820, AMERICAN MACHINIST.

Wanted — Position in publicity department of manufacturing establishment in Eastern territory; experienced in the preparation of copy and with the details of cut making and printing. Box 681, AMERICAN MACHINIST.

Mechanical engineer and draftsman, university graduate, seeks engagement; twelve years' experience in designing, manufacturing of general automatic machines, machine tools, refrigerating machines, heating, plumbing, ventilating, power plants; A-1 references. Box 808, AMERICAN MACHINIST.

OHIO.

Mechanical draftsman, 23 years' practical experience on engines, special machinery, jigs and special tools; Ohio or Pennsylvania. J. H. Pillings, 77 Elm St., Cincinnati, O.

Superintendent or general foreman, practical gas-engine builder, 15 years' experience, age 36, American, open for engagement September 1. Address Box 787, AMER. MACH.

PENNSYLVANIA.

A good man out of a job—If you want a works superintendent, write me; firms paying less than $4000 need not answer. Box 813, AMERICAN MACHINIST.

Wanted—Responsible position with a gear-cutting firm; 14 years' experience; also familiar with office work; middle age; A-1 references. Box 819, AMERICAN MACHINIST.

WISCONSIN.

Position as superintendent, assistant superintendent or general foreman by young mechanic of character and ability; technical graduate, foundry, and general machine-shop practice, 14 years' experience, 9 on gas and gasolene engines; ambitious, energetic, hustler; understands modern up-to-date methods; gas-engine work preferred. Box 786, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted—Tool designers for small interchangeable work; also several competent toolmakers experienced on fixtures, dies and gages. Address, with full particulars as to experience and wages required, Ross Rifle Company, Quebec.

CONNECTICUT.

Wanted—Several competent all-around jobbing machinists. The Eastern Machinery Co., New Haven, Conn.

ILLINOIS.

Wanted—A thorough up-to-date superintendent to take charge of shop employing about 250 men and building a line of pumps and hydraulic machinery; plant located in middle West. Address Box 801, AMER. MACH.

Wanted—Foreman of experience for manufacturing small, intricate, interchangeable parts. Must have executive ability and be able to make machinery and operators work at maximum efficiency. Write fully, giving age, experience and wages wanted. Address Box 795, AMERICAN MACHINIST.

Wanted, draftsmen — We want capable draftsmen of either electrical, mechanical or general experience. If you would like to change your position or its location, write and tell us about the character and extent of your work. Address, giving full particulars, to Western Electric Company, Dept. N. 29, Chicago.

Wanted—An expert designer, with experience in complicated automatic machinery; applicants will facilitate matters by giving references in first reply, as none will be accepted without careful investigation of record; state also nationality, age, salary required, whether married or single, and give a brief but clear account of training and experience. Box 815, AMERICAN MACHINIST.

Wanted—Foreman blacksmith; man who can take charge of blacksmithing in shop manufacturing comparatively heavy machines; must be a strict disciplinarian; must have had thorough experience on tempering, and have complete knowledge of working of high-speed steel; must also be well experienced on steam-hammer work; only sober, industrious married man need apply; state experience and wages expected. Address Box 803, AM. M.

MICHIGAN.

Machine-shop foreman—Wanted, a competent machinist to take charge of the die and tool-making department of a large factory; applicants must show actual experience as foreman and must have a thorough knowledge of die designing and drafting. Address Box 744, AMERICAN MACHINIST.

MINNESOTA.

Wanted—A competent foreman of wide experience to take charge of the machine shop in a factory manufacturing D. C. and A. C. machinery; for the right man we have an exceptional opportunity. None but those who can get the work done need apply. Apply Box 783, AMERICAN MACHINIST.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

MISSOURI.

Wanted—A competent toolmaker familiar with gas engine, jigs, templates, etc.; also a competent test-floor man. Witte Iron Works Co., Kansas City, Mo.

Salesman wanted, thoroughly familiar with selling large gas engines and gas producers; give references, salary wanted and full information in first letter. Weber Gas & Gasoline Engine Co., Box 398, Kansas City, Mo.

Wanted—An up-to-date foreman for woodworking machinery shop in a large Western city, one who has had experience in agricultural implement work, and is competent to get modern results. Address Box 798, AM. M.

NEW JERSEY.

Wanted — Mechanical electrical draftsmen; only first-class men need apply. Box 508, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted—First-class draftsmen, good designer of machinery; must be reliable and capable of taking charge; position steady if services are satisfactory; state age, nationality, experience, expectations and references. Address Box 804, AMERICAN MACHINIST.

Diemaker wanted, who has A-1 experience, to make dies on all kinds of automatic wire-forming machines; permanent position will be given to the right party; state wages and age. Appy at the Metal and Wire Goods Mfg. Co., 521-535 North avenue, opp. freight house, Plainfield, N. J.

Wanted—Competent draftsman as foreman where eight others are employed; must have experience and ability; one familiar with printing machinery preferred; steady position if satisfactory; give references, age, salary expected and experience. Address Box 805, AMERICAN MACHINIST.

NEW YORK.

Wanted—Mechanical engineer, draftsman. Room No. 1114, 97 Cedar St., New York.

Milling-machine hands of experience wanted on duplicated parts. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn.

Wanted—Machinists for floor work; good wages and steady employment will be given competent men. Box 817, AMER. MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—First-class men as toolmakers on punches and dies, also light high-grade jig and fixture work. Remington Typewriter Factory, Ilion, N. Y.

Wanted—Man familiar with wafer razor-blade grinding and honing machinery; good wages; state experience. Address F. M. Lawrence, 11 East 24th St., New York City.

Experienced machinist capable of taking charge as foreman of shop employing 40 to 50 hands. Must be capable of handling men, and a good executive. State experience in detail, and salary wanted. Box 797, AM. M.

Two first-class toolmakers wanted on fine automatic machinery, metal patterns and experimental work; good pay, steady work to right men; vicinity of New York City; state age, experience and reference. Address Box 814, AMERICAN MACHINIST.

Wanted — Detail draftsman on medium heavy machinery, in city of 25,000 people, 100 miles from Chicago; must be of good character and have had fair experience; prefer married man; state experience and pay expected. Address Box 816, AMERICAN MACHINIST.

Wanted—Experienced draftsmen on dies, jigs and fixtures; also men capable of working out experimental drawings and machine details; factory pleasantly located in small town; permanent position to competent men. Address Box 781, AMERICAN MACHINIST.

Wanted—Foreman for factory manufacturing instruments of precision in large quantities; must be up-to-date in modern methods, well versed in interchangeable duplicate work and able to handle help to advantage; state age, experience, nationality and salary expected; also give references. Address A-1, Box 782, AMERICAN MACHINIST.

OHIO.

Wanted—High-grade machinist for engine work. S. M. Jones Company, Toledo, Ohio.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Several first-class draftsmen on detail and assembly drawings; state age, experience and salary. Box 746, AMERICAN MACHINIST.

Three or four competent mechanical draftsmen. In repying, give full information, including rate expected. Box 686, AM. MACH.

Mechanical draftsmen, two technical graduates, experienced transmission-machinery men; good permanent positions for capable men. Box 34, Cleveland, O.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Chief mechanical draftsman, technical graduate, experienced transmission machinery; good permanent prospects with growing concern in Ohio; state definite qualifications and salary expected. Box 802, AMER. MACH.

PENNSYLVANIA.

Wanted—Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A first-class operator on B. & S. automatic screw machines to take charge of screw-machine department in a growing factory. Box 807, AMECICAN MACHINIST.

Wanted—Expert tool and die-makers, familiar with cutting and drawing dies for sheet-metal work; state experience and wages desired. Address The General Metals Manufacturing Co., 2240 Jackson street, Scranton, Pa.

The Monotype Company maintains a free school for training young machinists to operate its tvpe casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Pierce Mfg. Co., Woonsocket, R. I.

TENNESSEE.

Wanted—An experienced cost keeper for machine shop and foundry; state age, experience and salary. Location in Tennessee. Box 784, AMERICAN MACHINIST.

Wanted—Several first-class lathe hands; open shop; steady employment and good wages to competent men. Apply Duke-Success Machine Works, Memphis, Tenn.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., of Milwaukee, needs more patternmakers, machinists and mouiders.

Wanted—Patternmakers. We want several first-class patternmakers; can give steady work to good men; write for booklet showing our plant, views of the city, etc. Madison is an ideal home city. Gisholt Machine Co., Madison, Wis.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., are constantly increasing their works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wis.

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German Designs of Air Compressors.

BY M. KURTH.

Nearly all German engine builders have more or less taken up the manufacturing of air compressors, each one representing in its design a special type, making it a great task to classify them all. It is merely the intention in this article to mention some of the most important designs, and those of particular interest.

In size the compressors range from the smallest hand-operated machines up to any desired capacity. They are steam, belt, or electrically driven, while the water-wheel drive is very rarely applied. The electrically driven type has during recent years particularly drawn the attention of the manufacturers, and a number of designs either direct connected or geared to the compressor are now on the market. The smaller sizes of the direct-connected type are running at speeds from 600 to 1200 revolutions per minute, giving excellent results and on account of their simplicity are very desirable machines.

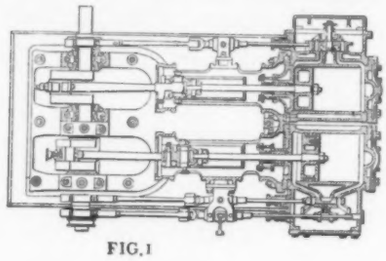
They are of short stroke, which keeps the piston speed within very reasonable limits. The most interesting features in the German compressor designs are embodied in the valve gear. All classes of valve gears, of course, are represented, the flat slide valve, the rotary valve, the poppet valve similar to our standard type of discharge valve, poppet valves of the kind applied to steam engines, rotary valves with poppet discharge valves located therein and others too many to mention. The first class, that of the slide-valve type, is represented in Fig. 1 by a compressor as built by the Maschinen, Fabrik Burkhard, Basee. The engines are fitted with the Rider cut-off-valve and the cranks are set at an angle to keep the tangential forces produced on the steam end as nearly alike as possible to those of the air end. This permits a very light flywheel. In capacity these compressors range from 2730 to 6825 cubic feet per hour.

In order to avoid the effect of the large clearance spaces the slide valve of the compressor is fitted with a little groove-shaped port, which at the end of the stroke connects both cylinder ends, thus producing pressure equalization which permits the inlet port to open at the beginning of the stroke, thus producing a nearly full suction stroke. The volumetric efficiency is thereby increased to 93 per cent., which the manufacturer guarantees. A back-pressure plate is fastened to the back of the valve, thus preventing the discharge air from returning. The two-stage compressors are provided with intercoolers of the condenser type and are either vertical or horizontal to suit local conditions. The most common practice is to locate the intercooler below the floor.

Fig. 2 shows a compressor with rotary valve serving both for inlet and discharge. This type is built by the Erfurter Maschinen Fabrik, Erfurt. Located above the rotary valve are two back-pressure valves to prevent the return of the discharge air. The principle of pressure equalization is also applied which, of course, becomes unavoidable on compressors with excessive clearance spaces.

A one-cylinder two-stage compressor of Klein, Schauzlin & Becker, Frankenthal, is illustrated in Fig. 3. The differential piston, which serves as a crosshead, is open and air cooled, while cylinder and heads are water jacketed. They are built for capacities from 2400 to 15,000 cubic feet per hour for a pressure of 100 pounds, and 600 to 2000 cubic feet per hour for a pressure of 300 pounds, running at a speed from 130 to 175 revolutions per minute, according to size, and are either of the horizontal or vertical type.

This company also manufactures compressors especially adapted for mining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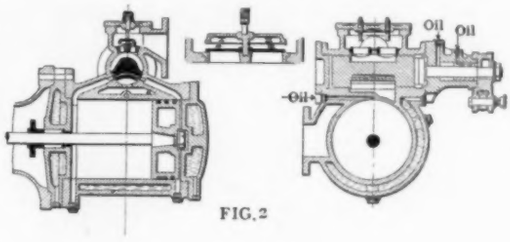


FIG. 2

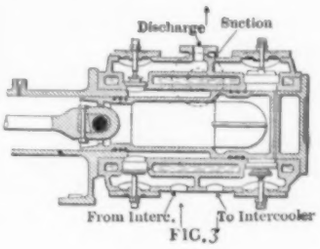
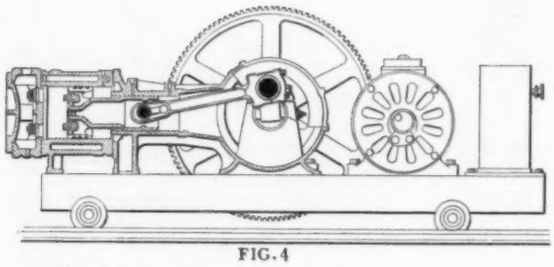


FIG. 3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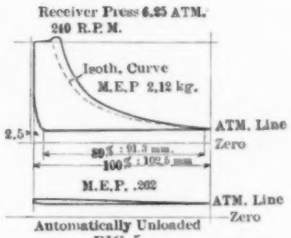

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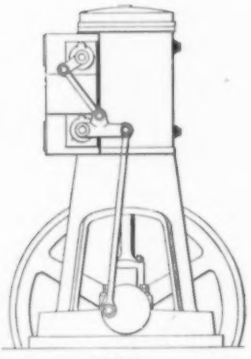


FIG. 7

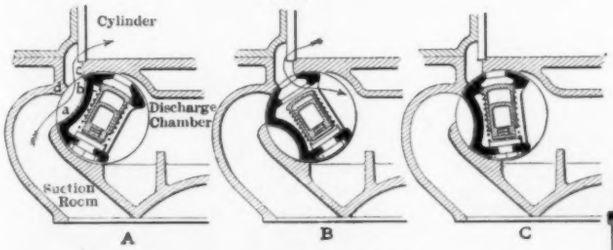
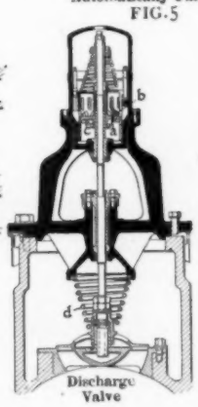


FIG. 6



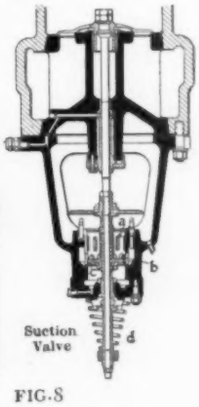


FIG. 8

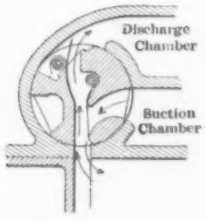


FIG. 9

GERMAN AIR COMPRESSORS.

purposes. Fig. 4 shows the general arrangement of such a compressor, of the single-stage type, which has its reason in the scarcity of water in some mines. They are motor driven for capacities from 450 to 550 cubic feet per hour. The clearance spaces are kept very small so that the compressor even at 90 pounds gage pressure shows a volumetric efficiency of 90 per cent. The suction valves are located in the piston and are operated by their own inertia. They are said to work very satisfactorily although springs are entirely eliminated. A receiver is located on the front end of the truck which forms the base plate for the whole machine. Fig. 5 shows copies of actual cards taken from a compressor as above described and indicate the performance at 240 revolutions per minute. The cards are taken from a compressor 10x10.

Koch, Bautelmann & Paasch, Magdeburg, are particularly on the market for high-speed compressors both of the horizontal and vertical type, either belt, steam or electrically driven. In capacity they range from 40 to 240 cubic feet per hour for a pressure up to 300 pounds and running from 200 to 375 revolutions per minute, according to size. These figures apply to the single-stage compressors. The cylinders are water jacketed, and the compressors have neither suction valves nor stuffing boxes, which simplifies the design greatly. The clearance spaces are zero, which assures great efficiency. A leather coupling connects motor and compressor for direct-connected type, thus eliminating shocks when the machine is started.

A very interesting compressor is that of the Struad valve type, Fig. 6. The suction valve is of the rotary type with the discharge valves located therein. According to the position of the piston the valve connects alternately the cylinder with the suction room and then with the discharge chamber. View *A* shows the position of the valve during the suction period when the air is entering the cylinder through the suction port *a*, passing by the groove-shaped recess of the valve *b*. While the piston is approaching the right-hand dead-point position the edge *c* of the valve moves toward the cutting-off edge *d* of the port which it is in line with at the end of the piston stroke. While the piston returns, the valve still moves in the same direction, thus bringing the discharge valves opposite the former inlet port and allowing the air to pass through as soon as receiver pressure is obtained as shown in view *B*. The position of the valve in the left-hand dead-point position of the piston is indicated in view *C*. The discharge valve has just been shut off and returned to its seat, which action, due to the cushion, is practically noiseless. The clearance spaces of this type of valve are from 2 to 2½ per cent., while they may be reduced to 1 or 1½ per cent. by locating the valves in the cylinder head. According to Professor Gutermuth these valves are very satisfactory. The Calvir & Company, Bielefeld, build vertical compressors of this type the general arrangement of the valve gear of which is shown in Fig. 7.

Schuchterman & Kremern, Dortmund, are builders of compressors with valves fitted with the Collman oil cataract, Fig. 8. Both suction and discharge valves are made of aluminum bronze and are self-acting. Connected with the valve spindle moves a piston, within an oil-filled cylinder *a*, which latter is provided with a series of openings *b*. The piston itself carries a disk-shaped valve *c*. In the position shown in the drawing with the valve closed, the piston has just closed the openings *b*. When the valve is lifted, the oil which is above the piston rapidly moves through the openings in the cylinder and also through the valve at the bottom of the piston. In this way the forming of a vacuum below the piston is prevented and the valve may open. The valve closure takes place very rapidly by

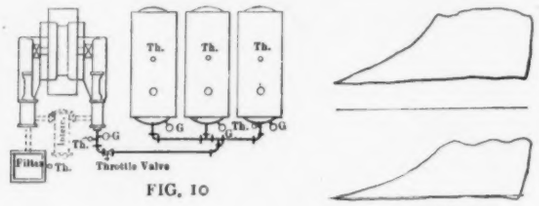


FIG. 10

FIG. 11

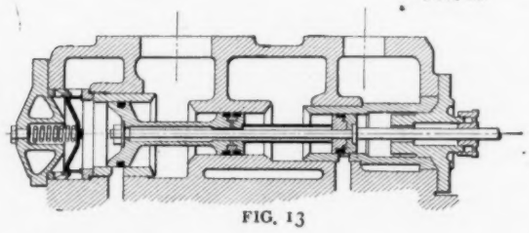


FIG. 13

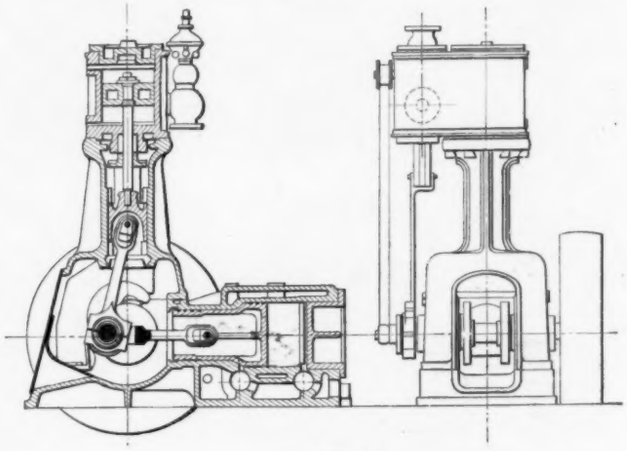


FIG. 12

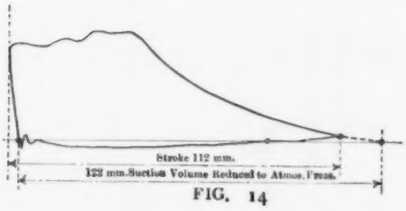


FIG. 14

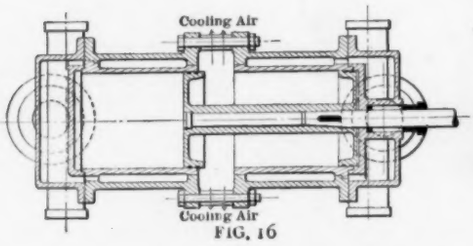


FIG. 16

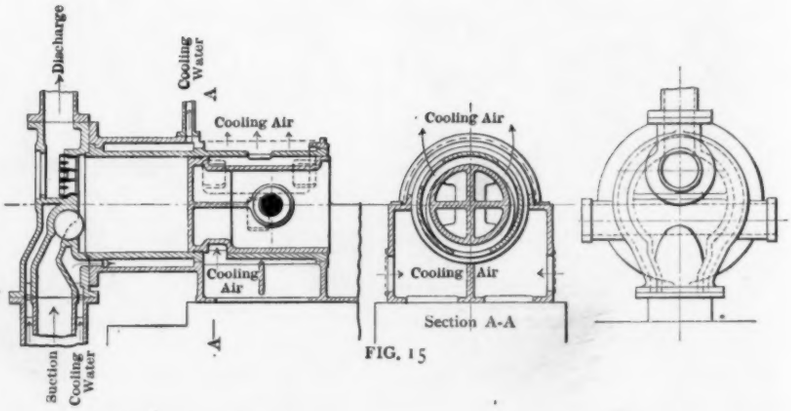


FIG. 15

GERMAN AIR COMPRESSORS.

action of the spring *d*, during which period the oil below the piston escapes through the openings *b*. Due to the peculiar shape of the openings the velocity of the valve toward its seat is decreased shortly before it closes entirely, thus preventing it from pounding.

The oil cataract is adjustable for almost any speed and this type of valve has given the best of results. The action of the discharge valve is practically the same as that of the suction valve. The former is provided with a stop to limit the lift. The advantages of the Collman valve as claimed by the manufacturers are simplicity, very little wear, adjustment, small clearance spaces, no gear mechanism and generous area, for which reason two inlet and two discharge valves suffice.

The Gutermuth valve, which has made its appearance during recent years, consists as shown in Fig. 9 of a very thin and extremely flexible steel plate, wound around a pin. It is very light, and as regards the flow of the air through the ports it shows practically no losses. According to the area required, these steel plates and their respective parts are arranged in groups, located side by side in a housing which is either conically fitted to the cylinder or fastened by other means. These valves are adapted for almost any speed and for pressures up to 1000 pounds. A Humbold compressor fitted with Gutermuth valves was recently tested. This compressor was of the two-stage type, electrically driven (direct connected) and of the following dimensions: Low-pressure air-cylinder diameter, 20 inches; high-pressure air-cylinder diameter, 12¼ inches; stroke, 20½ inches; revolutions per minute, 116. Final air pressure, 75 pounds gage. A free air capacity of 44,145 to 55,910 cubic feet per hour was guaranteed, the power required for 35,316 cubic feet per hour to be 0.092 kilowatt, and the temperature of the air when leaving the high-pressure cylinder not to exceed 100 degrees Celsius. The Fig. 10 shows diagrammatically the arrangements made for the test. The air was drawn through the filter into the low-pressure cylinder and passing through the intercooler arrived at the high-pressure cylinder whence it was discharged into the receivers. The receiver capacity, including the piping, amounted to 2273.17 cubic feet.

A throttling valve, pressure gages and thermometers were applied and located as shown in the sketch. The high-pressure discharge air was kept at the constant hight of 70 pounds gage pressure by means of the throttling valve, the total number of revolutions, to the time when the receiver pressure had risen to 70 pounds, was noted and temperature readings were taken. The total number of revolutions was 1642; the test lasted 14.225 minutes, which averaged 115 revolutions per minute. The weight of the air in the receivers and piping before the test was 163.97 pounds, and that after the test 971.14 pounds, therefore the actual weight of the air furnished was 807.17 pounds, which reduced to suction temperature (20.75 degrees C.) and atmospheric pressure represents 11,759.22 cubic feet. The suction capacity of the compressor is therefore 45423.4 cubic feet per hour. The horse-power required expressed in kilowatts amounted to 0.086 kilowatt per 35.31 cubic feet per hour, which represents 7.5 per cent. less power required than was guaranteed by the builders. The low-pressure piston displacement being 50,501.8 cubic feet per hour, a volumetric efficiency of $\frac{45423.4}{50501.8} = 90$ per cent. was obtained. Copy of the actual indicator cards is shown in Fig. 11.

A horizontal vertical compressor fitted with Gutermuth valves was recently exhibited at the World's exhibition at Liege, Belgium. The exhibitors were the Maschinenbau A. G. Humbold. Fig. 12 shows this compressor in section.

Pokorney & Wittekind, in Bockenleinn, and also Neumann & Essen, Aachen, are the builders of compressors with the Koster piston valve. Fig. 13 shows a section through the valve port. In connection with this valve I wish to report on the peculiarity of one of these compressors which showed a volumetric efficiency of 109 per cent. The theoretical piston displacement represents 100 per cent., and some of the readers will smile. However, looking over the card Fig. 14 it is seen that, due to the peculiar flow of the air, the cylinder is filled with air of higher than atmospheric pressure, and reducing the volume of the final pressure to atmospheric pressure will result in a larger capacity than the theoretical piston displacement. The actual length of the card being 112 millimeters, and the pressure being 1.1, atmospheric will result $\frac{122}{112} =$ 109 per cent. These figures were obtained from a test made on a compressor of the two-stage type, fitted with Koster piston valve, capacity 211,890 cubic feet per hour.

Mr. Richter, in his articles on Thermal Investigation of Air Compressors, gives two sectional views which indicate the most effective device for air cooling. The air entering the suction pipe being heated on its way, due to the friction, may be cooled down by providing water jackets around the intake passage, and the piston may be air cooled by drawing the compression stroke by suitable recesses, allowing the air to follow during the entire stroke. As the most efficient inlet valve for compressors he indicates the rotary valve. This certainly is superior to any other type of valve, as it offers the least resistance which may arise from contraction of ports. For discharge valves he advocates the use of simple one-ring valves as so frequently applied in water-pump design. They may be arranged in groups, and should be kept small in reference to larger and fewer valves. In all probability compressors of the type as indicated in Figs. 15 and 16 will never have a future, as they become commercially impracticable on account of the cost.

In the addition of conveniences and luxuries the modest bicycle shares with the more pretentious automobile. *Engineering* (London) illustrates and describes a three-speed hub, having ratios of 0.68, 1 and 1.47, or about 50 per cent. increase at each change, giving the rider a choice of a very low gear for hill-climbing, a normal gear and a high gear for use on the level or on slight down-grades. "Free-wheeling" is obtainable on every gear, and every revolving part runs on ball-bearings, whether pedaling or coasting. The gear changes are made by a sliding spur gear, moved by a chain emerging from the end of the fixed axle and connected to a lever conveniently located, the return motion being produced by a spring. It does not appear that the mechanism is designed to act as a brake also. The weight is 12 ounces more than an ordinary hub, and it does not require alteration of the bicycle frame. This gear is designed and constructed by M. Pedersen, Dursley, England, who has also devised special machinery for its manufacture, including a machine for cutting ratchet teeth on the inside of one of the spur gears.

Bulletin No. 48, of the American Chamber of Commerce, Paris, has an interesting article by Alfred S. Heildelbach, member, on "Modern Reproductions of Antiquities," in which is a great deal of information valuable to those who have a fancy for such things. The bulletin contains an account also of a meeting of the Chamber on May 2, which was addressed by Eugene N. Foss, who, it will be remembered, is at the head of important machinery-manufacturing concerns in New England. Mr. Foss, having been introduced by the president, addressed the members on the subject of tariff revision and reciprocity, predicting that there would be an early revision of the tariff in the United States and that this revision would come much sooner than was anticipated, as public opinion in America was drifting strongly in that direction. Mr. Foss expressed the opinion that it had been found impracticable under existing conditions in the Senate to pass reciprocity treaties, that tariff revision would eventually be along the lines of a maximum and minimum tariff with reciprocity clauses. And he concluded by urging the Chamber to persist in its efforts to create public opinion favorable to revision and to reciprocity.

Over 20 steam shovels are working on the Panama Canal, many of them in the deep Culebra cut. Though using small Belgian cars, handling material cost in February but 68 cents per cu. yd., average.

The Polar Planimeter and Some of Its Special Applications—II.

BY J. Y. WHEATLEY.

VOLUMES OF SOLIDS.

We have thus far devoted our attention to the description of the planimeter, and to obtaining a clear understanding of the principles governing its construction and use—the examples given having been chosen for the purpose of indicating the wide range of application of the instrument and the method by which its principle can be utilized in the various operations of applied mathematics.

The following examples are intended to illustrate the use of the planimeter in the class of problems with which the mechanical engineer is particularly concerned. It may be claimed for these that the only application of the planimeter to their solution, consists in the measurement of areas and hence that they cannot be classed as problems solved by the planimeter, but only as examples of graphical integration. While this may be true in part it must be remembered that the solution of these problems in the manner to be described, is entirely dependent upon our ability to rapidly and accurately measure the areas of figures, often having very irregular outlines, and that in the vast majority of cases the accurate measurements of these areas would be an impossibility without the aid of the planimeter—thus making the method itself unworthy of confidence and precluding its use. The truth of this statement will be fully demonstrated by considering the extent of the error in any result due to even a slight error in the measurement of these areas.

It is also equally true that with ordinary care in drawing the figures, and in the use of the planimeter, the degree of accuracy of the results is in many cases greater than that attainable by any other method employed for their determination.

The following method for finding the volume and weight of an irregular solid is not only very accurate when the planimeter is used in the operation, but in many cases it is the only method which will give results with sufficient accuracy to be of any value.

Let us suppose that the figure $A\,B\,C\ldots.H\,K\,X\,A$ is the elevation of one-half of a dumb bell, and that we desire to obtain its volume in cubic inches.

It is evident that the dumb bell is generated by revolving the figure $A\,B\,C\ldots.H\,K\,X\,A$ about $A\,X$ as an axis, and that the cross section of the dumb bell at any point is a circle whose radius is the ordinate of the given figure at that point—that is, the cross section of the dumb bell at the point C will be a circle whose radius is $c\,C$; the cross section at H will be a circle whose radius is $h\,H$, etc.

We now assume a base $A'\,X'$ equal to the length $A\,X$ and draw through the upper figure a number of vertical ordinates, and prolong them to the base $A'\,B'$ in the manner shown in the figure. We then measure the length of each ordinate of the given section as $A\,B$, $c\,C$, $d\,D\ldots.X\,L$ and take from a table of areas of circles those areas whose radii are equal to the ordinate lengths measured. The areas thus obtained are, as we have already shown, the areas of the cross sections of the dumb bell at the points through which the ordinates were drawn and, having obtained the area corresponding to each ordinate in succession, we lay off these values as ordinate lengths to the base $A'\,X'$. Thus, $A'\,B'$ is laid off equal to the area of a circle whose radius is $A\,B$; $d'\,D'$ represents by its length the area of the circle whose radius is $d\,D$, and so on for each ordinate. Drawing a smooth curve through the upper ends of these ordinates we obtain the figure $A'\,B'\,C'\ldots.H'\,K'\,X'$ whose area in square units is equal to the volume of the dumb bell in the corresponding cubical units.

Careful attention must be paid to the scales used if the two figures are not drawn full size. If one linear inch of ordinate of the lower figure represents one square inch of area of cross section, then the area of the lower figure in square inches will be the volume of the dumb bell in cubic inches; but if one linear inch represents more than one square inch, the proper correction must be made to the results of the measurements.

This method for finding the volume of a solid is entirely general in its application and is applicable to a very large number of engineering problems. In the example given above, the volume was symmetrical, but the method applies equally well to irregular volumes. The method is used for finding the quantities in earth and rock excavations, the contents of reservoirs, capacities of boats or other receptacles, and in fact to all solids, the areas of whose cross sections are capable of measurement.

By using the planimeter for the measurement of the areas of these cross sections of an irregular solid, as well as for the area of the final figure, the degree of accuracy and the facility with which the measurements are made cannot be obtained by any other known method.

CENTER OF GRAVITY OF A PLANE AREA.

The determination of the center of gravity of an irregular area is not only one of the most important but also one of the most unsatisfactory of the problems which engage the time and practice of the engineer.

When we consider that in even our most recent works on mechanics the methods given for finding the center of gravity of an irregular plane area are to either "plot the given figure on cardboard or thin sheet tin, cut out the plotted area and balance it on the edge of a knife or ruler," or after cutting out the figure to "hang it at different points on its periphery by a string attached to a nail in the wall," the importance of an instrument which will determine this point with an accuracy only exceeded by the mechanical integraph will be apparent.

There are at least three methods by which the center of gravity and the statical moment of an irregular area can be obtained with the planimeter. On account of the frequence and importance of the problem two of these methods will be given here while the third will be illustrated later in connection with the determination of the other properties of sections.

FIRST METHOD.

Let it be required to find the center of gravity of the plane area $O\,R\,P\,Q\,X$ about $O\,Y$ as an axis.

Beginning at O we divide the base $O\,X$ into any number of equal parts and draw through each such part an ordinate parallel to $O\,Y$—the greater the number of ordinates the greater will be the accuracy of the results. In Fig. 5 the distance between the ordinates was taken as .2 of an inch so that the horizontal distance of the successive ordinates from $O\,Y$ is .2, .4, .6 inch, etc.

We then measure with a decimal scale the length of each ordinate contained between the base $O\,X$ and the curved or irregular line $O\,R\,P\,Q\,X$ and multiply each such ordinate length by its distance from $O\,Y$. This value being found for each ordinate, we lay off on each ordinate a linear distance equal to the product thus obtained for that ordinate. Thus, $rR' = rR \times Or$, $pP' = pP \times Op$ and so on for each ordinate—the scale used to lay off these values being the same as that by which the ordinates of the given figure were measured. We then draw a smooth curve through the ends of the ordinates thus laid off which gives us the figures $O\,R'\,P'\,Q'\,X$.

From the method of construction of the figure $O\,R'\,P'\,Q'\,X$ it is evident that its area is the moment of the area $O\,R\,P\,Q\,X$ about $O\,Y$, and since we know from mechanics that the distance of the center of gravity of any area from an axis is equal to the statical moment of that area with reference to that axis divided by the area itself, we have, denoting this distance by x,

$$x = \frac{moment\ of\ area}{area} = \frac{area\ O\,R'\,P'\,Q'\,X}{area\ O\,R\,P\,Q\,X}$$

Should the given area be bounded on the lower side by an irregular line instead of a straight line, as shown in our example, the operation would be exactly

the same—the length of ordinate of the given figure being the length intercepted between the upper and lower bounding lines and this length multiplied by its distance from $O\,Y$ would be plotted from $O\,X$ as a base as in the example given. This operation when repeated with $O\,X$ as the axis will give the distance of the desired point from $O\,X$, and the intersection of the lines drawn parallel to $O\,Y$ and $O\,X$ at the distances given by the above operations will give the location of the center of gravity of the entire area.

The same unit should be used throughout—that is, if the ordinates of the shaded area are measured in inches, the ordinates of the moment area must be laid off in inches of the same value and the areas of the two figures expressed in square inches.

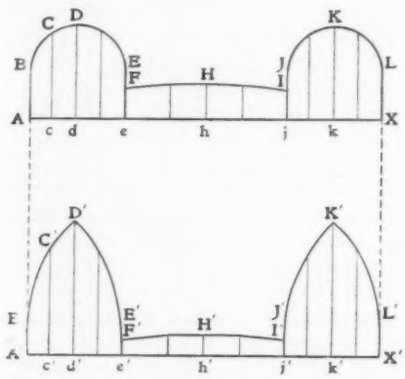


FIG. 4

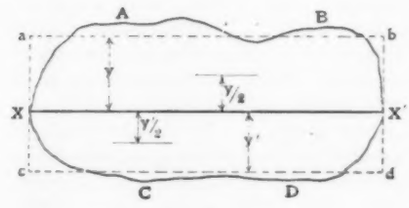


FIG. 6

If, instead of finding the center of gravity of the center area, we desired to find the center of gravity of only a portion of it as, for example, the area $O\,R\,P\,Q\,q\,p\,r\,o$, we obtain the horizontal distance from the Y axis of the center of gravity of this partial area by dividing the area $O\,R'\,P'\,Q'\,q\,p\,r\,O$ by the corresponding area $O\,R\,P\,q\,p\,r\,O$ and so on for any partial area desired.

SECOND METHOD.

What we have termed the averaging principle of the polar planimeter can be used to obtain the position of the center of gravity of a plane area in the following way:

Let $A\,B\,D\,C$, Fig. 6, be an irregular figure whose center of gravity we wish to determine. We first draw through the figure a straight line $X\,X'$ in such a position that its length will be the greatest length of the figure, in the manner shown. We then make the length of the tracer arm of the planimeter equal to the length $X\,X'$ and trace the upper part $X\,A\,B\,X'\,X$ of the given figure. From the averaging principle of the planimeter already described we know that the circumference of the wheel multiplied by the number of revolutions recorded for this tracing will give the distance y of a line $a\,b$, parallel to XX', which will be equal to the average distance of the irregular line $X\,A\,B\,X'$ from $X\,X'$, and the center of gravity of the area traced must lie on a line parallel to XX' and at a distance from it equal to $y/2$.

Performing the same operation for the lower part of the figure we get the corresponding distance $y'/2$.

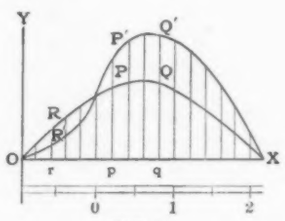


FIG. 5

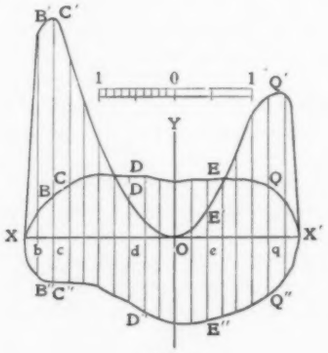


FIG. 7

THE USE OF THE PLANIMETER.

Knowing the area $X\,A\,B\,X'\,X$ of the upper part of the given figure and the area $X\,C\,D\,X'\,X$ of its lower part, we can assume these areas to be weights having the known distance $y/2$ and $y'/2$ as lever arms and at once determine the distance of the center of gravity of the entire area from $X\,X'$. Repeating the operation for a vertical axis through the figure we are at once able to locate the position of the center of gravity of the given figure.

Which one of the methods described should be selected for any given figure will evidently depend upon the shape, size and other conditions of that particular area, but with care very accurate results can be obtained by the use of either method.

MOMENT OF INERTIA OF AN IRREGULAR AREA.

The method for finding the moment of inertia, moment of resistance and other properties of irregular sections by the use of the planimeter, about to be described, like those already given for finding the center of gravity, will give very satisfactory results, provided the work is carefully done, and the measurements accurately taken. The methods will be found entirely general in their application, and can be employed for all structural sections as well as for the irregular areas selected for illustration.

As will be seen in an example to be given later, they apply equally well for a solid as for a plane area, and should be used for these determinations for irregular sections when the mechanical integraph is not available.

FIRST METHOD.

This method for finding the moment of inertia is almost exactly the same as the first method described for finding the center of gravity, except that the scaled intercepts of the given figure are multiplied by the *square* of the distance of the ordinate from the axis YY instead of its distance, as in the former case. Thus, in Fig. 7, suppose that we desire to find the value of the moment of inertia of the figure $X\,B\,D\,Q\,X'\,E''\,C''\,X$ with reference to the vertical axis $Y\,Y$.

We first draw the horizontal axis $X\,X'$ and draw a number of vertical equidistant ordinates through the given area. After carefully measuring the length of each ordinate intercepted by the given area, such as $B''\,B$, $D''\,D$, $Q''\,Q$, etc., we multiply each intercepted ordinate length by the square of the distance of that ordinate from the given axis $Y\,Y$, and lay off each value thus

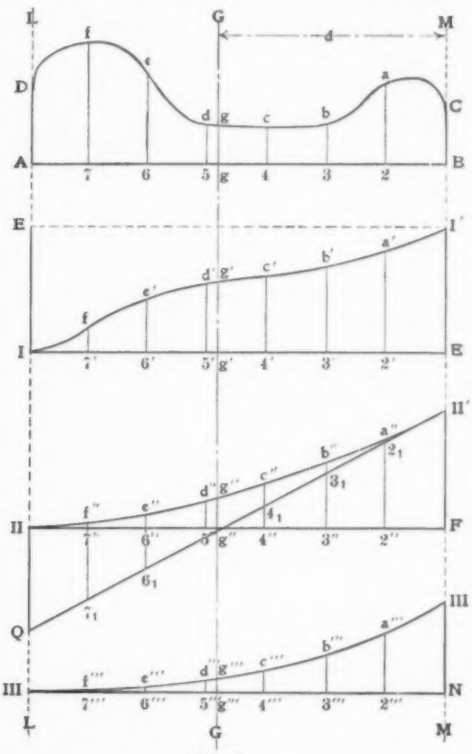


FIG. 8

obtained on its corresponding ordinate from XX' as a base. Thus, the length $bB' = B''B \times \overline{Ob}^2$, $dD' = D''D \times \overline{Od}^2$, $qQ' = Q''Q \times \overline{Oq}^2$, and so on for each ordinate

Connecting the ends of these ordinates by a smooth curve gives the area $XB'D'OE'Q'X'OX$.

If these ordinate lengths were measured and laid off to an inch scale, the area of the figure $XB'D'OE'Q'X'OX$ in square inches would be the moment of inertia of the shaded area about YY in inch units.

From mechanics we know that the square of the radius of gyration of any area is equal to the moment of inertia of that area divided by the area itself, so that we have for this case—denoting the radius of gyrations by k

Square of radius of gyrations $= k^2 =$

$$\frac{area\ XB'D'OE'Q'X'OX}{area\ XBDQX'E''C''X}$$

We also know from the same source that the moment of resistance of a section is equal to the moment of inertia of the section divided by the distance of its extreme fiber from its neutral axis, and hence this value is at once obtained from the figures by dividing the area of the derived curve by the greatest distance from the axis of the boundary of the figure. This value is also termed the "modulus of the section," and can be found very accurately by the use of the planimeter by a simple method, usually given in any text book on mechanics, and which need not be given here.

VOLUME, CENTER OF GRAVITY, MOMENT OF INERTIA AND OTHER PROPERTIES OF A SOLID.

While I have already given several methods by which the values of the moments of inertia, statical moments, moments of resistance and other properties of irregular beam or other areas can be obtained with the planimeter, I will describe here another method for determining these values which will give quite as accurate results as those previously described, and which would be the method chosen if all of these properties were desired for a beam section of irregular shape in the absence of the integraph.

This method has the additional value of allowing the results of the different operations to be read from the same diagram, as well as furnishing a graphic representation of those operations.

With careful use of the planimeter and accuracy in laying off the values furnished by it, the accuracy of the results obtained by the following operations will be found to be very satisfactory and worthy of confidence.

In the following example a symmetrical area has been taken for illustration to simplify the problem, but the method is equally applicable to any section whatever, whether symmetrical or unsymmetrical, and regardless of any irregularity in its periphery.

The section may be drawn to any scale whatever or have different scales for its horizontal and vertical dimensions; but these scales must be constantly kept in mind and corresponding allowance made in all subsequent operations and results.

Let us suppose $ABCD$ of Fig. 8 to be the half section of a double-headed rail which we wish to use as a beam for a given span and load, and we desire to determine those properties of the section required to determine its fitness for the use intended.

In this case the section is assumed to be full size for the sake of simplicity.

Assuming the center line of the section as a base we draw through the section a number of parallel vertical ordinates in the manner shown, thus dividing the section into a number of parallel strips. Where the shape of the given section is irregular the ordinates should be drawn closer together, as this has a very great influence on the accuracy of the results of the operations following.

The area of the section and weight in pounds per foot of the rail are at once easily found with the planimeter in the manner already described.

We now proceed to construct the *curve of areas* in the following manner: We first draw the base IE parallel to AB and project downward to it all of the ordinates we have drawn through the given section. Having adjusted the planimeter to read square inches of actual area we begin at the point A and measure in succession the areas $ADf7$, $ADe6$, ... $ADa2$ and finally the entire area $ADCB$.

We then lay off on each ordinate a distance in linear inches equal to the area in square inches of that portion of the given section included between AD and the given ordinate; thus, $7'f'$ is made equal in lineal inches to the number of square inches in the area $ADf7$; $6'e'$ is made equal to the area $ADe6$; $5'd'$ to the area $ADd5$ and so on for each ordinate so that the last ordinate EI' represents the total area $ADCB$. Connecting the ends of these ordinate lengths with a smooth curve we have the area IEI', the curve II' being termed the *curve of areas*.

From the method of construction of this curve it is evident that the area IEI' is the moment area of the original section about MM as an axis, and since we know from mechanics that the distance of the center of gravity of any plane figure from a line taken as an axis is equal to the moment of the figure about that axis divided by the area of the figure, we have as the horizontal distance of the center of gravity of the section from the axis MM

$$d = \frac{area\ IEI'}{area\ ABCD}$$

To obtain the *curve of moments* for the given section $ABCD$ we construct the curve $IIII'$ from the figure IEI' in exactly the same manner as we obtained the curve II' from the original section. Thus taking IIF as a base we project down to it the ordinates drawn through the given area and lay off on each ordinate a length equal to the area of that portion of the figure IEI' lying on the left of the given ordinate. As in the first case we lay off $7''f''$ equal to the area $I7'f'$, $6''e''$ equal to the area $I6'e''$ and so on for each ordinate when FII' will be equal to the area IEI'. Connecting the ends of the ordinates thus obtained we have the curve $IIII'$ which is the curve of statical moments of the given section.

The area of the figure $IIFII'$ is the numerical value of the moment of inertia of the section $ABCD$ with respect to MM as an axis.

In order to obtain this value of the inertia moment as a length instead of an area, and to obtain the value of the moment of inertia of the section with respect to any other ordinate taken as an axis, we construct the curve $III\ III'$ which is the *curve of moments of inertia* of the given section. This curve is obtained from the curve $II\ II'$ by exactly the same methods as those employed to obtain curve $II\ II'$ from curve II', or curve II' from the given section, so that the length of the final ordinate $N\ III'$, being equal to the total area of the figure, $IIFII'$, represents the moment of inertia of the section, as explained above.

The values obtained by the operations just described for the distance of the center of gravity, and the statical and inertia moments have all been with reference to the axis MM. As these values are usually desired with reference to an axis GG passing through the center of gravity of the section $ABCD$, they can be obtained with reference to the gravity axis either by calculation from the values obtained for the axis MM, or by drawing an axis GG parallel to MM and passing through the center of gravity of the given section already formed as described above, and then measuring the lengths on this axis intercepted between the different curves and their bases.

Thus the length $g'g'$ intercepted between the curve II' and its base is equal to the area of that portion of the given section lying on the left of the axis GG. In like manner the intercepted length of $g'''g'''$ of the curve $III\ III'$ is equal to one-half of the numerical value of the inertia moment of the section $ABCD$ with reference to the gravity axis GG.

Since the square of the radius of gyration of a figure is equal to its moment of inertia about the given axis divided by the area of the figure, its value for the given section $ABCD$ for any desired axis is at once found, while the moment of resistance is determined with equal ease from the drawing.

As we have used only half of the rail

section in the calculations just described, the values for the inertia moment and other properties found must be multiplied by 2 to obtain their value for the entire section.

In the description just given of the method of construction of the different curves we have stated that the length of any ordinate in linear inches was equal to the number of square inches contained in the area represented by that ordinate.

In the practical application of this method of construction, however, it will be found that if we do lay off these ordinate lengths so that one linear inch of ordinate is laid off for each one square inch of area of the preceding curve, the resulting figure will in many cases be so large that the measurement of its area with the planimeter becomes inconvenient. For this reason the actual length of ordinate laid off is usually only ½ or ⅓ of the number of square inches of area of the curve from which it is derived; or in other words, ¼ or ⅓ of an inch of ordinate is laid off for each square inch of area—the unit of length selected for any given case being dependent upon the size of the section and other conditions of the problem.

In Fig. 8 the section is supposed drawn full size, but in the construction of the curves *I I'*, *II II'*, and *III III'*, one linear inch of ordinate of any curve represents two square inches of area of the preceding curve, and hence the length of any ordinate of any curve must be multiplied by 2 to find the area of the preceding curve represented by that ordinate. This ratio of ordinate length to area for any given calculation is termed *the base* and in our example, since one inch of ordinate represents 2 square inches of area, the base is 2; if one inch of ordinate were laid off to represent 3 square inches of area, the base would be 3, and so on. It is evident from this that to obtain the numerical value of any quantity represented by an ordinate of a derived curve, the length of the ordinate must be multiplied by the base for any ordinate of the curve *I I'*, by the square of the base for any ordinate of the curve *II II'* and by the cube of the base for any ordinate of the curve *III III'*.

In Fig. 8 drawn to a base 2 the area of the section $A\,B\,C\,D = E\,I \times 2$; the statical moment of the section with respect to the axis *M M* will be equal to $F\,II' \times \frac{2^2}{2}$ and the inertia moment will be given by $N\,III' \times \frac{2^3}{2}$.

One great advantage possessed by this method of calculation is that we are able to obtain from the diagram the area, center of gravity, statical moment, and inertia moment for any *portion* of the original section as easily as we have obtained them for the entire area. Thus, suppose we wished to find the values of these properties for the partial area *A 5 d D*. The area of this portion would be given by multiplying the ordinate *5' d* by 2; the distance of the center of gravity from *5 d* would be obtained by dividing twice the area *I 5' d'* by the area *A 5 d D*, while the inertia moment would be obtained by multiplying the area *II 5'' d''* by 4.

The method just described is capable of extension to the solution of an innumerable number of engineering problems and, with the aid of the polar planimeter, will give the most satisfactory results. By its use many problems of almost daily occurrence in the engineer's practice, such as the finding of the shear, bending moments, deflections and other properties of beams and girders, questions in hydraulics, the dynamics of a steam engine, pressure-line determination in arches, and many others are solved with a saving of time and labor impossible by the ordinary process of mathematics.

With the Coradi compensating planimeter we have been using in our discussion we are able to measure a figure of approximately 100 square inches area, and if carefully traced the maximum error in the measurement of that area need not exceed .04 per cent. even for the most irregular areas.

With a thorough understanding of the principles governing the construction and operation of the planimeter, and an ability to utilize those principles in the operations of applied mathematics, there are few problems presented to the engineer for solution in which the use of the planimeter cannot be made of almost incalculable value.

Italy's Growing Dependence upon Water Power Instead of Coal.

At page 362, Vol. 29, part 1, we gave some figures regarding the estimated supply of coal in the principal countries of the world. The development now going on in the use of water power in northern Italy, as described in a recent report from Consul Dunning, of Milan, is probably typical of what will occur in some other countries when there comes a real shortage of fuel. Mr. Dunning says:

As receding coal supply bears its constantly intensifying influence upon industrial development, the water power of north Italy begins to take its place as one of the main assets of the Kingdom. In the last annual issued from the Milan consulate I referred to Italian water supply in general as the probable cornerstone of the new industrial structure which will be built along the peninsula. Of comparatively recent origin, the subject ought to appeal specially to American manufacturers, since it is bound to be through application of the vast store of water in the north Italian mountain ranges that our competitors here will be able to meet us on what will be more than equal terms if American mills continue to be dominated by that "King Coal" which was recently referred to before an association of New England cotton manufacturers as the controlling element in the present situation. In the Italian cotton trade, for instance, the fuel problem, which is rapidly advancing to a serious stage throughout Europe, is rendered scarcely of moment through the rapid development of electrical energy generated by water power in the not far distant hills. All the newer cotton mills are run electrically, and many of the older ones are to re-equipped with the same system to take the place of their steam plants. The outlook of the Milan cotton manufacturer upon the future is not clouded by any doubts of his ability to compete with the mills of other countries on the score of power cost.

NOT TO DISTURB IRRIGATION.

One of the problems connected with the more extended use of water supply in northern Italy has been dictated by the danger that too much of the natural flow might be made use of, to the detriment of the inhabitants of the upper valleys, who need a considerable amount for irrigation. This difficulty has been avoided by a storage system, which appears to be working out successfully, and by means of which all interests seem to be cared for equally. One of these reservoir groups was established in 1889, on the river Gorzente, where were built two storage basins, with a combined capacity of 5,750,000 cubic meters of water, to supply the city of Genoa with water and electric power. The company has resolved to re-equip its works and bring them up to date—to produce a total available power supply of 6000 horse-power. Another company, which is exploiting the water supply of the Apennines, has established plants at four points in that range.

THE GOVERNMENT DEEPLY INTERESTED.

Impetus has been given to water-power studies and electrical transmission by the news that the Italian Government, under the direction of the King, whose interest in such practical enterprises is notably keen, will invite the two great railway lines, Ferrovie Medditeraneo and Ferrovie Medidionali, to devote a large part of 1907 to the question of electrical traction, and to take up various projects for trials on a large scale. On the line of the Meditteraneo there has been tried a third-rail system for use in the service between Milan and lakes Maggiore and Lugano. After three years this appears to have given satisfactory results.

In northern Italy nearly all the small cities and a large number of villages are supplied with electric light, while many of them have installations of hydro-electrical power, which have played a strong part in the commercial advancement of these thriving towns. The city of Como, one of the principal silk centers of Europe, draws its electrical lights and

power from a station near Porlezza, on the Lake of Lugano, through a wire line 27 miles long and at a tension of 2000 volts. The station includes a canal and tunnels 11,000 feet in length, by which is utilized a typical mountain torrent with a fall of 835 feet. The station contains 5 groups of generators.

SMALL FACTORIES FAVORED.

The installation at Verona is slightly different from these others, inasmuch as in that city there exists a canal for industrial purposes with a fall of about 35 feet, which supplies a considerable number of factories. A part of the power in this canal is utilized to generate a triphase current at a tension of 3000 volts, supplying about 1000 horse-power, which is distributed to small industries in the city at an average consumption of 35 horse-power each.

The city of Brescia, 67,000 inhabitants, in the upper Lombard district, is served by two hydro-electrical installations, and a third will soon be put into operation and will embody the latest inventions and appliances for this sort of work. The station is at Ponte Caffaro, in the Giudicaria valley, where there is obtained a fall of nearly 850 feet of water. About 10,000 horse-power will be supplied from this station.

GROUPS OF VILLAGES SUPPLIED.

Apart from these installations, which serve the smaller cities, there are a number of others in northern Italy which supply electrical power to groups of villages spread over a territory more or less extended. Throughout Lombardy important manufactures are depending more and more upon electrical transmission for their power, and anything like a complete list would be a very long one. One of the most interesting plants is at Gromo, noted in Europe as the first in Italy to use a current of 40,000 volts. The wire line supplies the Crespi textile mills at Nembro. Numerous others might be cited, and every year sees electrical transmission developing toward the point where all the rich country centering on Milan will be reasonably independent of receding coal supply and the increasing high cost of fuel.

Of vital moment in any complete consideration of the water powers of northern Italy as related to the industrial development of Milan is the plan now well on foot to add 40,000 horse-power to the available motor power which can be drawn upon by manufactories in the city. This plan comprehends the use of the waters of the Adda river, which leaves the lake of Lecco at Lecco City.

The use of calcic hydride (hydrolithe) for inflating balloons is proposed by M. Jaubert. Water acting on 1 kg. of it will release 1000 liters of hydrogen at atmospheric pressure in a manner similar to generation of acetylene from calcium carbide.

The Works of the John Cockeril Company at Seraing, Belgium.

BY EMILE GUARINI.

The works of the John Cockerill Company shown in the general view Fig. 1 are among the most gigantic on the Continent, and include all branches of mechanical engineering. The works actually use electrical energy up to 3300 horse-power, of which total 1800 horse-power is produced by engines utilizing the gases from the blast furnaces. The distribution of power is by direct current at 250 volts; for lighting purposes current at 120 volts is used. The central station receives the gas directly from the blast furnaces. All the 47 cranes at the works are electrically operated and almost all the transmission apparatus, the centrifugal pumps, the crushers, and the ventilating system, are operated by motors.

The machine shops are among the most interesting parts of this plant. Shop No. 1 is 396x148 feet and is devoted to the finishing of forgings and castings. An adjacent building is utilized for a cock and valve factory and another neighboring structure contains the polishing department. The toolmakers' department is in a separate but conveniently located building and here there is a series of precision tools used in making gages.

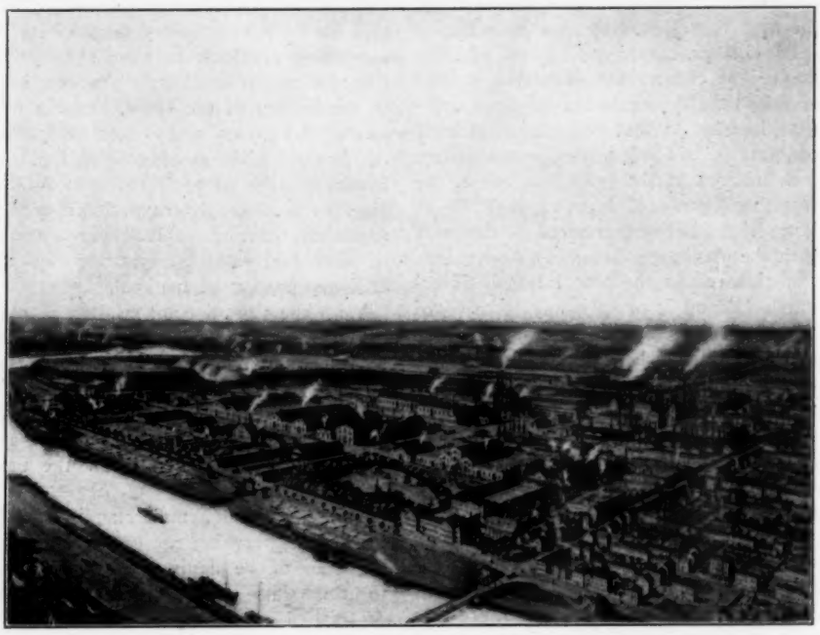


FIG. 1. WORKS OF THE JOHN COCKERILL COMPANY AT SERAING, BELGIUM.

FIG. 2. VIEW IN MACHINE SHOP.

models and tools for the plant. There are also here backing-off lathes for relieving the threads of taps, etc.

Shop No. 3, shown in Fig. 2, is devoted to the fitting of machines of moderate size. In this shop also are the special machines for finishing locomotive axles. The main portion of the shop is 328x52 feet and is equipped with an electric crane of 40 tons capacity and two traveling cranes of 5 tons each. The manufacture of rapid-fire guns takes place in a nearby department, Fig. 3, together with that of cannon of large caliber. This workshop has an area of 32,290 sq.ft. and contains among other things some lathes capable of finishing work up to 49 feet long, two ponderous machines for boring gun barrels, and a rifling machine for cannon, which will work up to bores of 9½ inches diameter.

FIG. 3. VIEW IN THE GUN FACTORY.

The erecting room of the locomotive shop has a capacity of 100 locomotives per year. Most of these are of light pattern with vertical boilers, for factory service, special tracks, etc. This workshop is supplemented by another for the light smith work, comprising the making of casings and piping, fitting of tenders, etc.

FIG. 4. VIEW IN MAIN ERECTING SHOP.

The principal erecting department, Fig. 4, is reserved for the construction of the largest machines and is a building divided into three portions, the middle one measuring 65 feet from floor to the meeting point of roof and walls. The hoisting apparatus includes a crane of 46 tons capacity, and another of 5 tons. Among the machine tools is a slotter which is at the same time serviceable as a vertical planer, having a stroke of 5 feet and a movable head, permitting the working of material which has a hight of 6½ feet. The largest of the lathes is capable of swinging a diameter of 46 feet and is employed in the turning of grooved pulleys, etc.

One large lathe was made especially for turning hydraulic plungers up to 6½ feet in diameter. The largest of the boring machines will work on cylinders up to 9½ feet diameter. There is in this place a massive cast-iron floor plate presenting a perfectly straight surface of 1600 sq.ft. As an object of interest, the smith shop exhibits a forging press, which has a maximum power of 2000 tons. The transportation of the ingots from furnace to press is accomplished by a traveling crane capable of lifting a load of 70 tons. In the smith shops are made apparatus pertaining to steam generators, reservoirs, converters, etc., and those relating to bridge and structural work. There are two divisions in this department, the first being fitted up for bending and forming sheets, hot and cold forging of iron, steel or copper plates. The foundry is almost wholly given up to the production of soft steel castings, by the Siemens-Martin process. There are two furnaces of 20 tons each for this purpose. The six blast furnaces are arranged for supplying hot metal to the converters of the steel works. The blowing engines are nine in number, six operated by steam and the others by the gas from the blast furnaces. The steam for the blowing engines and other motors of the blast-furnace division is supplied by boilers heated exclusively by the waste gases from the blast furnaces.

The shipyard of the John Cockerill Company is situated at Hoboken, near Antwerp, and covers 15 acres. The shops there are provided with everything necessary for the preparation of plates, frames, forged parts of steel or iron, etc. A central electric station has been installed for the generation and supply of power to the different machines used in ship-building.

About 40 city smoke inspectors held a convention in Detroit a few days ago for the purpose of forming a National Association of Smoke Inspectors. This it seems to us is an excellent idea, for the various members of this association by exchanging ideas and experience can enable any city that cares for such things to have the benefit of the best knowledge there is in the abatement of what is getting to be almost as serious a drawback to life in some of our American cities as it has been for generations in certain English cities. Little smoke need be made with bituminous coal.

Gas-Engine Calorimetry.

BY F. E. MATTESON.

Although the gas engine can be operated much more cheaply than any steam engine on the market at the present time, comparing pounds of coal per horse-power hour, in one case using a producer plant, and in the other a steam boiler as a medium, yet the brake or delivered horse-power of the gas engine only represents about 25 per cent. of the available heat in the gas used. The remaining 75 per cent. is used up partly in warming the jacket water, part of it goes out in the exhaust, and part in radiation. The object of the following experiments was to determine the proportionate distribution of this heat.

The amount of heat absorbed by the jacket water was easily determined by weighing the water thus warmed, noting its temperature before and after leaving the jacket, but the difficulty came in designing a calorimeter which would measure the heat carried out in the exhaust, satisfactorily.

THE CALORIMETER.

Fig. 1 shows the essential features of the Matteson and Rose calorimeter. The main tank *A* is 10 inches in diameter and about 42 inches in hight. This chamber is kept partly filled with water and the exhaust gases are led into it through a 2-inch pipe *C*, which is fitted with a high-temperature thermometer or a pyrometer for determining the temperature of the gases entering the calorimeter. It extends down to within about 4 inches of the bottom of the tank and the hot gases must pass up through the water in their course through the calorimeter. By this operation the gas gives up most all of its heat to the water; but this action causes a spray of water to be thrown upward which is caught by the baffle plates *B*, to prevent its being carried out with the exhaust. The gas makes several turns in passing around and between the plates to get to exit pipe *D*, and in so doing loses most of the water. Any moisture that might be still carried on up through the long vertical passage *D* is trapped in an ordinary steam separator *E*. *D* is also fitted with a thermometer for determining the temperature of the gases as they leave the calorimeter. Water is supplied to the calorimeter through a ¼-inch pipe *K* leading into *C*. The water outlet is at *I*, and by means of the valves in *K* and *I* a constant level is maintained in the tank. The surface of the water, as might be expected, since it undergoes varying changes of pressure due to the intermittent explosions of the engine, will not be very well defined. However, by throttling the water-gage *H* at the bottom by means of a cork with a small hole through it, the average water level in the calorimeter can be determined very closely. Inlet *K* and outlet *I* are fitted with thermometers, and by noting these temperatures and weighing the water that passes through in a given length of time one can determine the amount of heat taken out of the gas. That heat which still remains in the gas as it leaves the calorimeter can be accurately determined as will be shown later in the calculations.

G is a water-sealed overflow which acts as a safety to prevent the water from rising too high and running over into the cylinder.

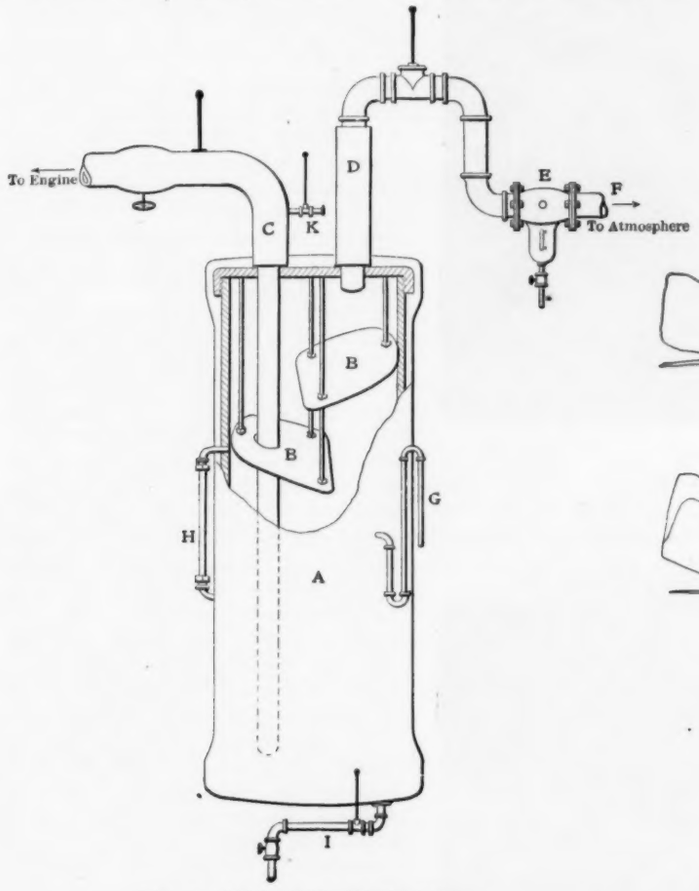


FIG. 1. GAS-ENGINE CALORIMETER.

EXPERIMENTS.

In preparation for a heat-balance experiment on the White gas engine it was necessary to equip the engine with a water-cooled friction-brake, an indicator and speed counters. One box counter was used to determine the revolutions, being attached to the reducing motion for the indicator while the other box counter was attached to the hit and miss mechanism that controls the admission valve and sparking apparatus, and therefore registered the number of explosions.

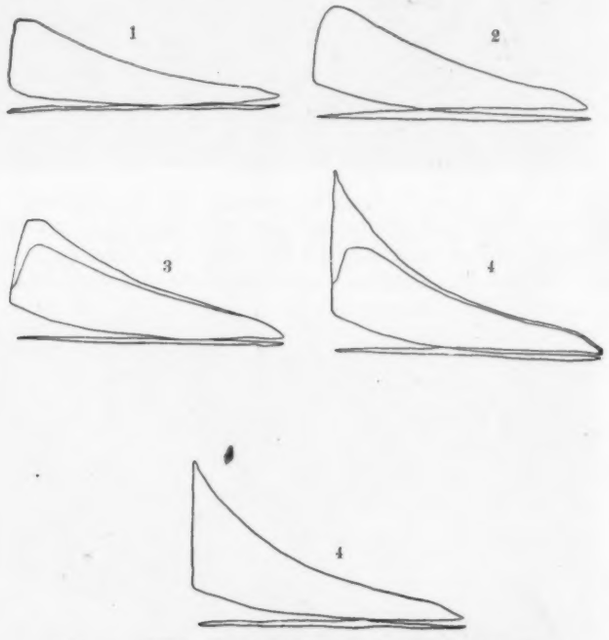


FIG. 2. INDICATOR CARDS TAKEN DURING TEST.

The jacket water was piped into a tank on a scales and weighed. The exhaust gas was piped into the calorimeter as described above. The gas used in the engine was run through a gas meter which had been calibrated and a gas bag which tended to maintain a uniform or steady supply of gas.

While a run was being made, a sample of the gas was passed through the Junker gas calorimeter and its calorific power determined. This was found necessary because the quality of gas used, which was from city mains, changed so, from time to time.

Four runs of one hour duration each were made. It was necessary to run the

engine for about an hour before taking readings in order to get constant working conditions. The brake load was adjusted, and the other conditions were made to correspond. The jacket water was regulated by means of a valve on the intake and by adjusting this flow the temperature of out-flowing water was maintained at about 160 degrees to 170 degrees F., as this temperature was found to be most favorable to best working conditions of the engine.

The temperature in the exhaust pipe adjusted itself according to the horsepower that the engine was delivering, and to the number of explosions and the temperature of the jacket water. It depended upon all of these factors, and it was therefore necessary to have these conditions constant first. Then too the pipes would take up heat at first, and the thermometer or pyrometer used to determine the temperature of exhaust gas from the engine for all of these reasons would not, for some time, register a constant temperature.

The flow of water through the calorimeter was meantime regulated so that the level in the glass stood about constant. Slight regulation of this flow was necessary during the run because of the impossibility of regulating two valves with an overflow between them open to the atmosphere so that they will pass exactly the same amount of water. However, with slight adjustment from time to time the level was maintained constant.

After all conditions had been made constant, readings were taken at intervals of five minutes, for one hour, and Table I shows the results obtained for four runs, averages for the hour only being tabulated.

The first run was made before the exhaust chamber and pipes and calorimeter had been covered with asbestos and, as might be expected, the radiation or unaccounted for heat was much greater than in the other three runs which followed and were made after all pipes had been covered.

The items in the tables, representing average readings which were taken, are self explanatory; but the items representing computations may require some explanation.

The heat units used up in indicated work were calculated from the mean effective pressure, as shown by indicator cards, examples of which are shown in Fig. 2, and from the number of explosions shown by the box counter.

Referring to Table I it will be seen that runs 2, 3 and 7 represent conditions corresponding to brake horse-power of 2.14, 4.21 and 6.78 respectively.

The average M.E.P was determined as usual from the indicator cards, and the average value tabulated.

$$I.H.P. = \frac{PLAE}{33{,}000}$$

Where

P = average M.E.P.
L = length of stroke in feet.
A = area of piston in square inches.
E = explosions per minute.

Mechanical efficiency $= \frac{B.H.P.}{I.H.P.}$ and ranged from 45 to 75 per cent.

The indicated work was reduced to B.t.u. per hour, on the basis of 772 foot pounds per B.t.u. The thermal efficiency represents the relation of heat units used in indicated work to the total available B.t.u.

In calculating the amount of heat absorbed by the jacket water, it must be borne in mind that one B.t.u. is the amount of heat necessary to raise the temperature of one pound of water from 38½ to 39½ degrees F., and for higher temperatures a correction factor must be used. The average correction factor for temperatures varying from 50 to 170 degrees is 1.002.

The heat absorbed by the calorimeter warms the water to about 100 degrees F., and is calculated in the same manner as that taken up by the jacket water. The exhaust gas while passing through the calorimeter has its temperature lowered from 600 to 700 degrees F. to about the same as that of water leaving the calorimeter, and still contains heat. The amount of heat which still remains in the exhaust gas after it leaves the calorimeter can be accurately calculated, since it is the amount of heat which must be taken out in order to lower the temperature of gas to 32 degrees F. Let Q_2 represent the B.t.u. remaining in the gas, then

$$Q_2 = \frac{(T_2 - 32) f_2}{(T_1 - T_2) f} Q_1$$

in which

Q_1 = B.t.u. already taken out of gas.
T_1 = temp. of gas entering calorimeter.
T_2 = temp. of gas leaving calorimeter.
f_1 = average correction factor for temperatures varying from T_2 T_1, and
f_2 = average correction factor for temperatures varying from 32 to T_2.

The B.t.u. unaccounted for is the difference between the total available B.t.u. and that which is represented in indicated work, jacket water and exhaust. It undoubtedly leaves the engine and pipes by radiation, and would be reduced considerably with engines whose pistons, as well as their cylinders, are water cooled. However, the heat thus lost by radiation only amounts to about 5 to 7 per cent. of the total available B.t.u.

TABLE I. THERMAL ANALYSIS—WHITE GAS ENGINE.

Run Number.			
1	2	3	4
Average r.p.m.			
206 9	209.5	203.4	196 5
Effective brake load in pounds.			
15.1	10.2	20.7	34 25
Brake horse-power.			
8.124	2.14	4.21	6 73
Average explosions per minute.			
83 7	50.5	71.5	92.
Average M.E.P. per explosion.			
45.2	65.45	65.55	69.5
Indicated horse-power.			
5 41	4.73	6.7	9 143
Mechanical efficiency per cent.			
57.7	45 2	62.8	73.6
Gas-meter cubic feet per hour.			
153.	98.2	151.	209.5
Cubic ft. of actual gas per I.H.P. hour.			
28 2	20.8	22.40	22.9
Cubic ft. of standard gas per I.H.P hour.			
26 2	19.9	21.7	22 0
Cubic ft. of actual gas per B.H.P.			
48 9	45.4	35.6	31.0
Cubic ft. of standard gas per B.H.P hour.			
47.1	44.1	34 4	29 9
B.t.u. in gas per cubic foot.			
602.	602.	600.	600.
B.t.u. in gas per hour.			
92106.	59125	90276.	125700.
Indicated work in B.t.u. per hour.			
13877.8	12131.5	17184.	23443.2
Brake work in B.t.u. per hour.			
7907.5	5483 4	10794.	17254.2
Thermal efficiency per cent.			
15 0	20 5	19.	18.7
Average temp. F. of jacket entering water.			
36.3	51.	50.28	50 62
Average temp. F. of jacket leaving water.			
137.6	160 8	160.6	166.5
Water from jacket. Pounds per hour.			
392.	236.	363.5	497.
B.t.u. absorbed by jacket per hour.			
39866.4	26016.6	40251.3	57832.9
Average temp. F. exhaust gas entering cal.			
332.9	415.	517.78	734 1
Average temp. F. gas leaving calorimeter.			
71.2	85 4	92.84	102.1
Average temp. F. of water entering cal.			
36.3	51.	50.28	50.62
Average temp. F. of water leaving cal.			
66.	84.	96 47	104 5
Water from calorimeter. Pounds per hour.			
600.8	471 5	501.	588 2
B.t.u. absorbed by calorimeter per hour.			
17840 8	15575.3	23164.2	31735.7
Calculated B.t.u. in gases leaving cal. per h.			
2622.6	2445 3	3210 5	3405.2
B.t.u. accounted for per hour.			
74207.6	56168.7	83810.	116417.
B.t.u. unaccounted for per hour			
17898 4	2956.3	6466 0	9283.
Percentage of heat unaccounted for.			
19 8	5.	7 17	7.5

TABLE II. THERMAL ANALYSIS—WHITE GAS ENGINE.

Run Number.			
1	2	3	4
Percentage of heat abs. in indicated work.			
15.	20 5	19 12	18.70
Percentage of heat abs. by jacket water.			
43.2	44.06	44 55	46.00
Percentage of heat carried out in exhaust, as determined by calorimeter.			
22.	30.44	29 16	27.80
Percentage of heat lost in radiation.			
19 8	5.	7.17	7.50
Total heat.			
100.	100.	100.	100.

The Iron-Clad Manufacturing Company.

A business which had its origin about 50 years ago in a tin shop started by Robert Seaman in what was then the town of Bushwick, Long Island, has grown to a factory employing from 1200 to 1500 persons, and has afforded one woman an opportunity to put into practice some of the philanthropic ideas which grew out of the observations of her earlier life. The concern referred to is the Iron-Clad Manufacturing Company of Brooklyn, New York, whose milk cans are seen on railroad baggage cars and station platforms all over the country, and whose name is well known to the users and dealers of steel barrels, soda-water fountains, range boilers and other plumbers' appliances, and of buckets, kettles, pots, pans and all the forms of enameled kitchen ware. The president of the company, Mrs. Elizabeth Cochrane Seaman, is probably even more celebrated than her establishment, which distinction she attained before becoming in any way connected with the latter. At that time (as Miss Cochrane) she was special correspondent for the New York *World*, and in preparing articles on the baneful conditions and hardships of life in tenements and factories, she saw many things which have had their effect in shaping her policy now that she has a factory of her own. It is only necessary to mention the *nom de plume* of "Nellie Bly" to recall to mind the famous trip which Miss Cochrane made around the world in order to demonstrate that the progress of material development had made a possibility of "Around the World in Eighty Days," as it has of other fictions of Jules Verne, which he considered impossible scientific fantasies. Miss Cochrane started her trip on November 14, 1889, and completed it in 72 days, 6 hours, 11 minutes and 14 seconds, and her account of it can be found in the Sunday *Worlds* published during February, 1890.

During four years prior to the death of Mr. Seaman, and the two years since, Mrs. Seaman has managed the factories, which she understands thoroughly; knowing that she would have this responsibility to carry, she worked for a year alongside of the men in the different departments, familiarizing herself with the manufacture of every detail of all the various articles which form the product. This evidence of a genuine desire to learn thoroughly would have been exceedingly commendable in a man, but in a woman it is quite remarkable and characteristic of the "Nellie Bly" spirit. Mrs. Seaman's policy has been to steadily improve the factory; new and improved machines are introduced, many of them being designed by the company's own mechanical talent, and built in the company's own machine shop; the plant is lighted by electricity and driven by electric motors, the current being furnished from their own power plant. It has its own branch from the Brooklyn Rapid Transit Company's tracks and its own electric cars for the transportation of its product to the water front or railroad stations. We shall in this article present an account of the facilities which are being provided for the welfare and entertainment of the employees, and then some things seen in the plant which are interesting from a mechanical standpoint will be described.

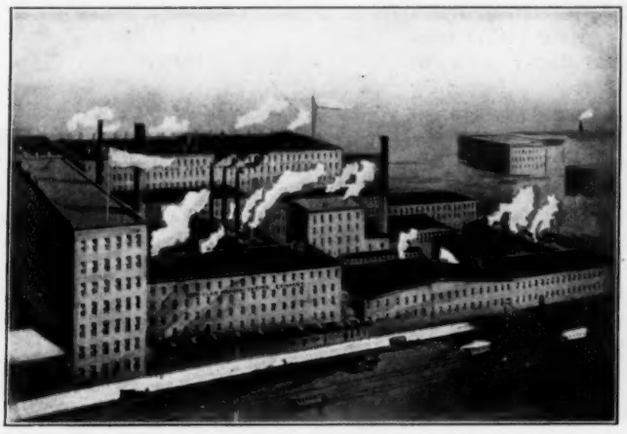


FIG. 1. PARTIAL VIEW OF THE IRON-CLAD FACTORIES.

FIG. 2. SHOW ROOM.

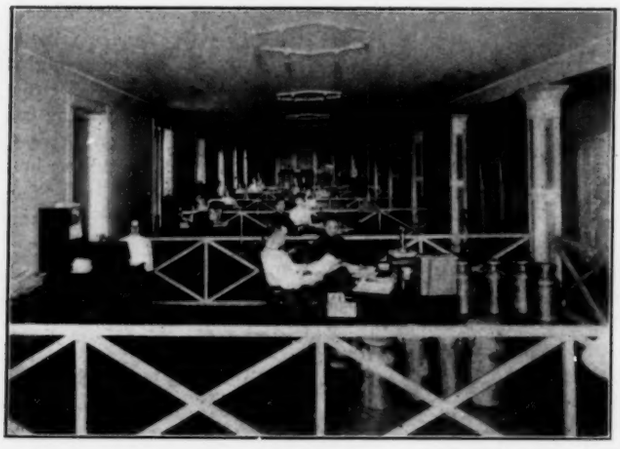


FIG. 3. SALES DEPARTMENT.

FIG. 4. COMMITTEE ROOM.

Fig. 1 is a partial view (though not exact for the present arrangement) of the establishment of the Iron-Clad Manufacturing Company, which occupies 125 city lots and is located at Flushing, Evergreen and Bushwick avenues, Cook, Varet and White streets, about 1¼ miles east of the

Navy Yard in Brooklyn. The office building, Nos. 204 and 206 Varet street, is 50x100 feet and has six stories. In the basement of this building are contained the toilet and shower baths for the use of the employees, who are furnished with free towels and soap, and it is intended to locate here a gymnasium, equipped with a bowling alley, punching bags, etc. On the first floor is the main show room, seen in Fig. 2, which contains numerous samples of the company's products. As it happens the most of the latter do not appear in the view shown, although a few vessels show in the background, and there can also be seen in front of the elevator door some glass cases containing polished ware. In the scheme of decoration employed in this building, different rooms are finished in different colors, the predominant color in the room just mentioned being red. On the second floor are the offices of the bookkeeping department. On the third floor is the sales-department office, which is so arranged that, as can be seen in Fig. 3, each member of the department has his own portion of space, insured to him by a railing, while the whole room is open and free from obstacles to light and air, and intercommunication is free and uninterrupted. This office is finished in green. On the same floor is a reception room for visitors and customers of consequence. On the fourth floor are the directors' offices, manager's office, and the directors' or committee room shown by Fig. 4. This room is finished in green and is illuminated by numerous incandescent lamps studding the cornice all around the room. On the fifth floor we find the library and club room, Fig. 5, which contains books, periodicals, games and a piano. On the same floor is the dining-room, Figs. 6 and 7, the private dining-room, Fig. 8, and the kitchen, Fig. 9. In the latter picture the products of the company are in evidence, namely the range boiler, the coal hod, the ash can back of it, and the kettles and pots on the range.

FIG. 5. LIBRARY.

The library, which is in charge of one of the employees in the capacity of librarian, contains 5000 volumes, subject to free circulation among the employees. Magazines and papers, popular and technical, are kept on file. Among the games provided are a pool and billiard table, ping pong tables (Fig. 7), parlor croquet, checkers, etc. These things form a small fraction of the matters looked after by an organization of the officers and employees, known as the Ironclad Library Association, of which the president is Mrs. Seaman, and which has, besides a board of directors and executive committee, the following committees: house committee, entertainment, resolution, education, recreation and mutual aid. A pretty thorough representative management is thus obtained, with the result that the facilities provided do not fail of complete utilization. The entertainment committee arranges for entertainments on Saturday nights, consisting of music, recitations, sleight-of-hand performances, lectures, debates, etc. The educational committee provides lectures, entertaining and instructive, the matter of which is largely derived from the knowledge and experience of members of the technical and commercial staffs of the company. The members of the mutual aid committee visit such employees as are sick or in distress, and render assistance where needed. A sick employee receives a certain portion of his salary, and in case of death aid is given.

In the summer a building in the mountains is leased to give an opportunity for recuperation to those employees who need it, and it is proposed also to have a place at the sea shore. The company furnished uniforms to a base ball club, which has given a very good account of itself in the field of local sport, and which journeys to and from the games in the company's automobile. A hunting and fishing club which obtains enjoyment and sport in the woods and on the waters of Long Island, steamboat excursions and festivals at Coney Island, an exchange where articles made by the employees are sold, giving them an opportunity to add something to their incomes, are other advantages which the employees of this establishment have.

FIG. 6. DINING ROOM.

A physician visits the factory and gives advice to the employees without charge to them, and if he calls at their homes, they have to pay but fifty cents, the remainder of the cost being paid by the

company. A small apartment in the factory is fitted up with such supplies as are necessary for the prompt relief and attention to wounds and accidents.

The house committee looks after the restaurant (Fig. 6), which is open for all the clerks, department managers, and foremen, about 150 taking lunch there every day. The cooking and service are performed by Japanese employed for the purpose, and the employees get the meals for less than cost. In the evening, when the dining-room is not needed for gastronomic purposes, it is converted into a recreation room, as indicated in Fig. 7. Upon a visit to the place once, shortly after Hallowe'en, I found that, instead of the colored decorations seen around the electric bulbs in the picture, the room was hung with numerous hollow pumpkin shells which had been put up for a Hallowe'en party.

FIG. 7. DINING ROOM TRANSFORMED FOR PLAYING GAMES.

The company not long ago completed the first floor of a new building, 110x225 feet, which being open all through, afforded a fine opportunity for a ball, and such a function was a feature of a house-warming held there one night before the building was gotten into shape for use; a stage was erected, the large room was well warmed, lighted and decorated, the Iron-clad band furnished music, and the celebration was an occasion of much pleasure to a multitude. This shop is now busy and noisy with industry, the machinery having been immediately installed, leaving the completion of the other floors to a later date.

THE ARRANGEMENT OF THE SHOPS.

Having in the foregoing attempted to give an idea of what is being done for the employees at the Iron-clad works, we shall now briefly state what the factory comprises, and advert to some interesting technical points.

The first floor of the main factory building contains the range-boiler department; on the second floor sheet-metal stamping is done; milk cans and dairy supplies are made on the third; sodium drums, oil drums and ice-cream cans are made on the fourth floor, and soda fountains on the fifth.

FIG. 8. PRIVATE DINING ROOM.

In the second factory, on the first floor are stamping rooms, spinning rooms, pickling and annealing rooms, galvanizing room, machine shop, and power plant. On the second floor are forming presses, and on the third floor is a stock room for such articles as milk cans.

On the first floor of the enameling factory is the packing room and shipping room; on the second floor the annealing room; on the third floor are coating rooms, and on the fourth floor the ovens.

Besides these buildings there are the malleable casting foundry, the brass foundry, and the steel-barrel factory. Gray-iron castings, when required (which is principally for machines built for the factory, as this material is not much used in the products), are made for the company by an outside foundry.

THE POWER PLANT.

The method of power distribution in the factory may be described as the group system of electric driving, inasmuch as the machines are, in general, driven by lines of shafts which are belt-driven by electric motors, the current being generated in the company's own power plant.

The boiler room contains one 400-horse-power water-tube boiler, Aultman-Taylor make, B. & W. type, and two 300-horse-power "Iowa" tubular boilers, which are equipped for firing with fuel oil, the equipment having been devised and put together by the company's mechanics. In equipping a boiler, it was provided with two oil burners, formed by running in a 1¼-inch wrought-iron pipe through an opening in the front of the furnace, this pipe being tapped into a 1-inch globe valve, with the bonnet removed, located just outside the front of the furnace; the regular pipe-connection openings of the *quondam* globe valve are occupied by bushings, into which are screwed ½-inch pipes, one for steam and one for oil,

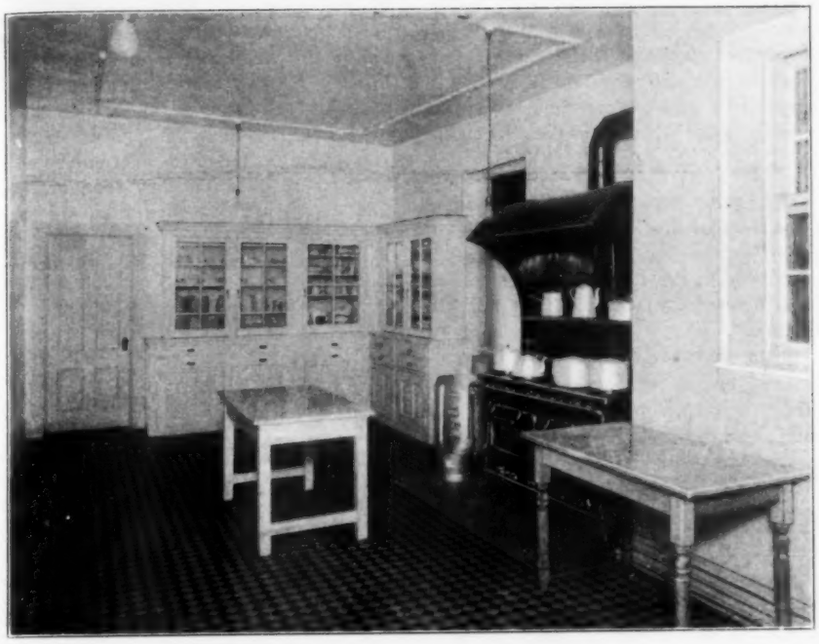


FIG. 9. KITCHEN.

nected in parallel. When the switch-board came, it was provided with the usual equalizing connection, but Mr. Taylor found that it was impracticable to use the latter, because the characteristics of one machine being different from those of the other, the large generator would carry too large a proportion of the load, which load in this plant is subject to much fluctuation; the result being that the small machine would be motorized most of the time. So the equalizing connection was dispensed with, the calibrated shunt on the large machine cut out; the large generator is overcompounded about 25 per cent., and on the small machine there is no overcompounding, as near as possible; and now, with the machines in parallel, any load up to 417 amperes can be put on the small machine, and any fluctuations over that will be taken care of by the large machine.

In Fig. 10, between and back of the two engines, can be seen the belt which drives the alternator supplying current for electric welding. This machine, which has a capacity of 100 amperes, furnishes

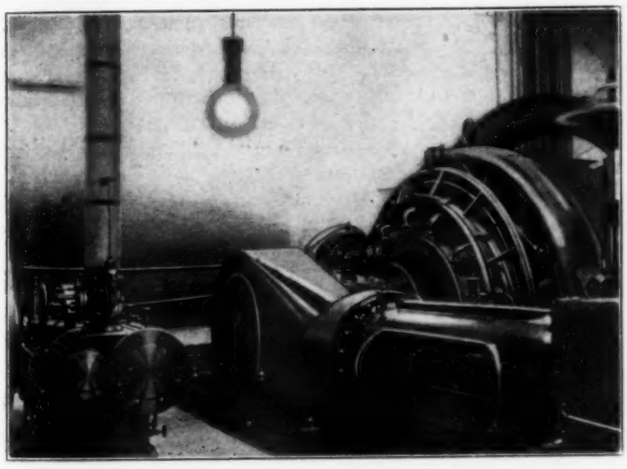


FIG. 10.

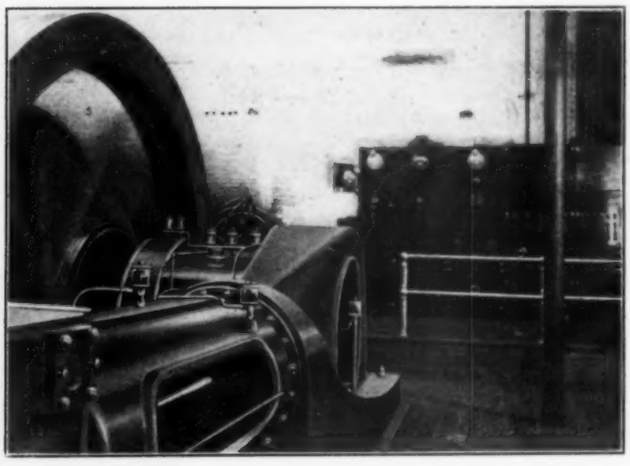


FIG. 11.

TWO VIEWS IN THE ENGINE AND DYNAMO ROOM.

with a regulating valve on each. The furnace is, of course, bricked up inside. The company has a contract for oil with the oil company at a price which makes it cheaper than coal. They state that they used 800 gallons in 10 hours for one 300-horse-power boiler, carrying steam at 120 pounds pressure.

Figs. 11 and 12 are two views in the engine and generator room, taken while the large engine was running. This is a 1000-horse-power double Fulton Iron Works Corliss engine, cylinders 20 inches by 40 inches, speed 100 revolutions per minute, which is direct-connected to a 525-kilowatt Bullock direct-current generator, 2200 amperes, developing a potential of 240 volts at full load. At the left of Fig. 10 can be seen a smaller unit, consisting of a 150-horse-power Fleming side-crank engine, cylinder 14 inches by 14 inches, speed 250 revolutions per minute, direct-connected to a 100-kilowatt

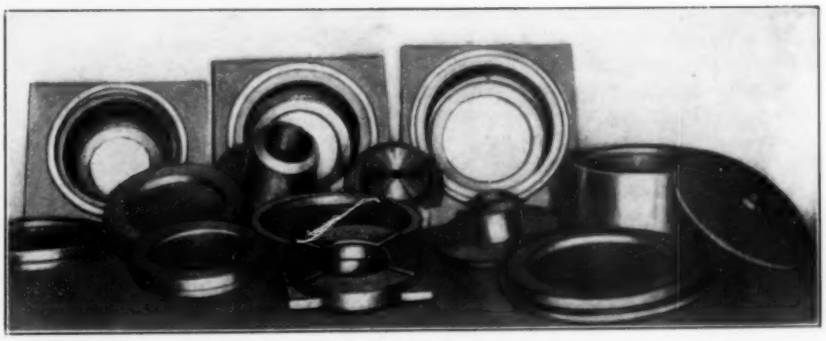


FIG. 12. SOME PATTERNS MADE OF TIN-PLATE.

direct-current generator, 417 amperes, 240 volts. A considerable portion of the switch-board shows in Fig. 11, and in reference to this it may be interesting to mention the way in which W. B. Taylor, the electrician and superintendent of the power plant, has his two machines con-

three-phase current at 350 volts, 52½ cycles, which is reduced through a choke coil to single-phase current. The alternator is driven by a 150-horse-power 220-volt direct current motor. It is Mr. Taylor's intention to replace the belted motor-generator set by a three-bearing di-

rect-connected set, furnishing single-phase current, 500 amperes, 350 to 375 volts. One of the pieces of apparatus in the engine room, which does not show in the picture, is an air compressor built by the Iron-clad Company, which is driven by a chain drive from a 100-horse-power 220-volt motor, taking 360 amperes and running at 550 revolutions per minute.

There are at present forty-nine 220-volt direct-current motors in the factory, ranging from 5 to 150 horse-power, of General Electric and Milwaukee makes. Some of the newest and largest machines are being put in with individual motor drives. Some of the power presses have their own motors. The largest press is driven by a 50-horse-power direct-connected motor and will form a blank 60 inches in diameter and 18 inches deep. The next largest one is direct-driven by a 40-horse-power motor and will form a blank 33 inches in diameter by 16 inches deep.

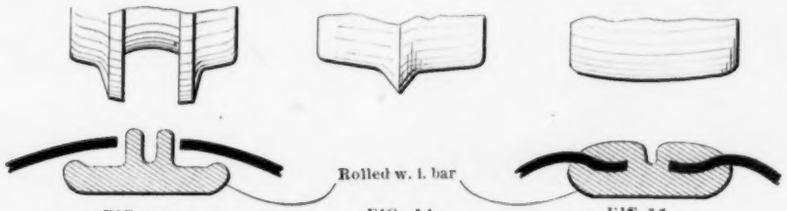


FIG. 13 First Roller, and Joint before Rolling

FIG. 14 Second Roller

FIG. 15 Third Roller and Completed Joint

THE "COLD WELD" SEAM FOR RANGE BOILERS.

MILK CANS.

One of the leading lines of this company's business is the manufacture of milk cans, many millions of its make being in daily use in the United States; the company is making about 500,000 new cans per annum, which is said to be about three-fourths of all that are produced in the United States. The Iron-Clad Manufacturing Company claims to have been the inventor of the railroad milk can, and it now produces some 300 different sizes and patterns, each locality having its own standard. Thus, the can used in the State of New York is a very heavy, substantial can holding 40 quarts, and weighing about 27 pounds, tinned inside and out, and equipped with various patented features, including the reinforcement of the breast with a one-half oval solid hoop, which like all the hoops used on milk cans, soda-water fountains, ash cans, etc., is not riveted or welded by a blacksmith, but is united by the electrical welding process, the use of which in this line of work is controlled in the United States by the Iron-Clad Manufacturing Company. Numerous other styles and sizes of cans are used in other sections of the country. The company has a large line of dairy supplies, including also cheese-factory cans, ice-cream cans, etc., and a patented can which holds milk, cream and butter all in one, and is provided with a lock having two keys, one held by the farmer shipping the can, and the other by the owner of the can, the service in which these are employed being largely the shipment of such supplies to people in large cities who receive them every day directly from the farms in their own cans.

TIN PATTERNS.

The factory contains a fair-sized machine shop, in which about 28 men are employed on maintenance and repairs of the machinery in the works, and also on the construction of new machines from time to time. The patterns required for the castings are made by the company, and it is safe to say that some patterns are made here which it would (in this form) be beyond the ability of most of the all-around expert patternmakers of the country to produce, for not a particle of woodwork enters into their construction. They are made of tin-plate, which the company finds it convenient to use because of the facilities which they have at hand for working sheet metals.

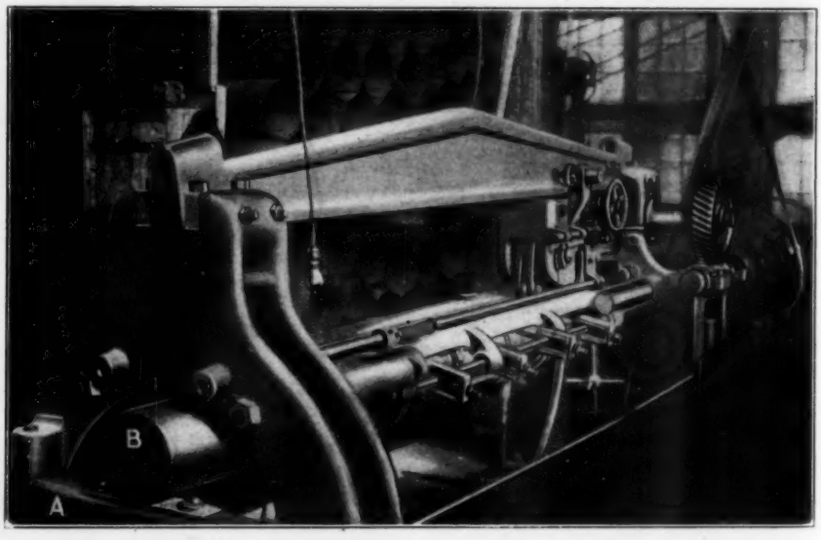


FIG. 16. MACHINE FOR MAKING THE "COLD WELD" SEAMS.

Fig. 12 shows a group of such patterns, which have an appearance of solidity, but are nevertheless all hollow and quite light and easily handled, and they have the advantage of being very durable. In the picture are patterns as large as 30 inches in diameter, made of XXXX tin.

SODA-WATER FOUNTAINS.

Tin in other forms besides tin plate is extensively used in manufacturing some of the products. Soda-water fountains are made of steel plate, tinned, with either electrically welded or riveted seams; and to still further protect the drum from chemical action it is lined with heavy block tin, the lining as pushed into the vessel being corrugated or crumpled so as to enter readily, but they soon get over this; as soon as the hydraulic test pressure of 500 pounds per square inch is put on, the lining expands and fills the vessel.

CLOSING THE SEAM IN BOILERS FOR KITCHEN RANGES.

Another line of pressure work is range boilers. The building formerly devoted to this department was burned down, and its site is temporarily roofed over; but it is expected to erect thereon a three-story building. The range boilers are built of steel sheets and made with the longitudinal seam either double riveted or made by a patented process (controlled by the company) which they call "cold-welding," and shown in Figs. 13, 14 and 15, made from rough freehand sketches; this work is done on the machine shown in Fig. 16, the traveling head of which is represented to a larger scale in Fig. 17. The operation is as follows: The hinged end piece *A*, Fig. 16, is swung open and the curved plate from which the boiler is to be made is slipped over the mandrel *B*, *A* being closed and locked. The mandrel *B* has a longitudinal groove in its upper surface, into which was previously placed a wrought-iron bar of special section shown in Fig. 13; the boiler plate is clamped fast by the devices seen in Fig. 16, and the traveling head of the machine carrying the first roller (about 4 inches diameter) is brought to the edge of the plate, and the roller forced down on the plate by means of the hand wheel and gearing. The head makes a round trip along the length of the seam, bending the edges of the plate down into the

grooves of the iron bar. This roller is then removed and replaced by the second one (Figs. 14 and 17), which spreads the vertical projecting lips of the bar right and left so as to embrace the edges of the boiler plate. The third roller, Fig. 15, is then put in the head and smoothes the joint down nicely. It is claimed for this joint that it is superior in strength to a riveted joint; it is very evident that the boiler plate is not weakened by holes, as is necessarily the case with a riveted joint. They have an analogous crimping process for the heads of these boilers.

Each boiler has four holes, usually for 1-inch pipe, which must be tapped out. They have a handy rig which they got up for doing this rapidly, consisting of vertical guides in which is a vertically adjustable head, which carries a tapping spindle with its axis horizontal. In front of this is a special swiveling truck adapted to receive the range boiler and allow it to be readily swung around to bring the different holes opposite the tap.

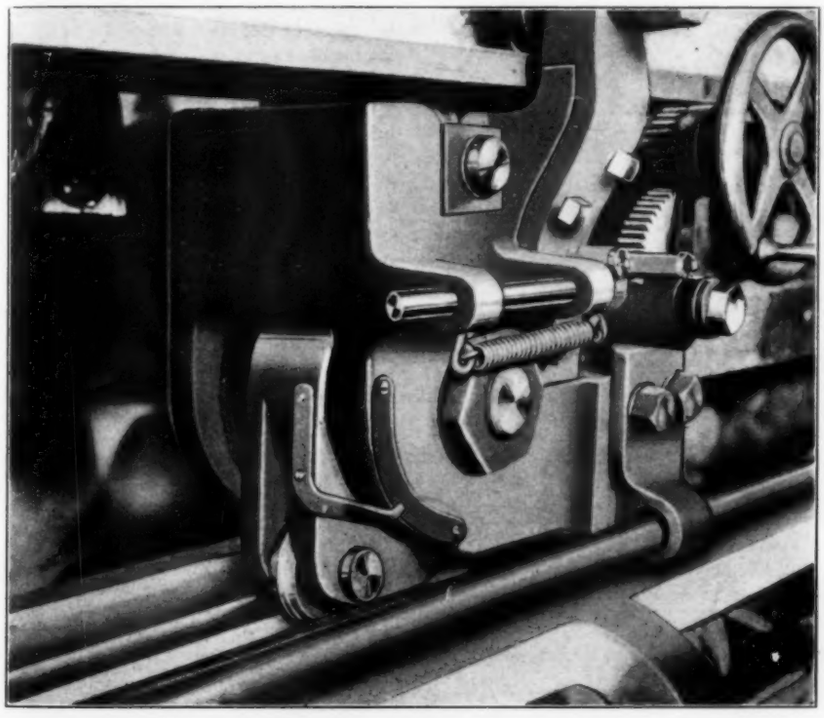


FIG. 17. ROLLING A SEAM ON A RANGE BOILER.

STEEL BARRELS.

The Iron-Clad Manufacturing Company has been experimenting on the steel barrel for the last ten or twelve years, but did not make much progress toward putting the barrel on the market until Mrs. Seaman became manager of the company, some six years ago, when she devoted a considerable portion of her time to the perfection and introduction of the steel barrel. A separate factory has now been erected adjoining the Brooklyn works for the manufacture of these goods, which are made in many sizes, from 5 gallons up to 500 gallons; the most common use made of them is for the transportation of oils, chemicals, paints, gasolene, and in fact fluids and semi-fluids of all kinds. The introduction of the automobile, and the growth in the use of the marine gasolene engine has done a great deal to increase the demand for them, since the safety, freedom from leakage, and the long life of the steel barrel make it a very valuable means of transporting and storing gasolene. For this purpose the barrel should be galvanized inside and out.

The company has special processes for making the barrels, the heads and bottoms being attached by the use of heavy electrically-welded hoops interlocked under great pressure. The side seams are riveted and brazed, and the chime hoops are electrically welded. For the bung-holes, malleable castings are used. One kind of barrel holding from 1 to 5 gallons and made with a removable head is quite useful for carrying a supply of gasolene on an automobile. H. J. K.

In the class of the spanking machine and similar funny inventions is a sparring machine, recently invented, which consists of a manikin having spring arms and boxing gloves, and operated by irregular cams driven by an electric motor, so that it delivers a variety of blows, and it is also capable of following its human antagonist over a limited area. The speed can be adjusted according to the agility of the man. The machine has one great advantage over its sparring partner—its capacity for taking punishment; it will never cry "enough!" though possibly it could be made to do so.

Letters to the Editor.

Press Tools for Marking a Sleeve.

Those of you who operate a panorama kodak have perhaps noticed the accuracy of the stamped figures and lines that indicate the different openings of the diaphragm. These eight sets of figures together with thin converging lines were stamped in one operation in a punch and die.

Fig. 7 shows the sleeve mount on which the operation was performed. If the lines leading from the figures to the edge of the sleeve had been straight, it would have simplified the making of the die somewhat, but as seen, the ends of the oblique lines had to end at just the right point; hence it was an accurate die to construct.

Fig. 2 gives an idea of the arrangement of the punch and die. *A* is a cast-iron shoe bored out to receive a machine-steel ring *B* and the center plug *C*. Another round piece *D* is placed on top and central with *C*. In the lower side of *D* are

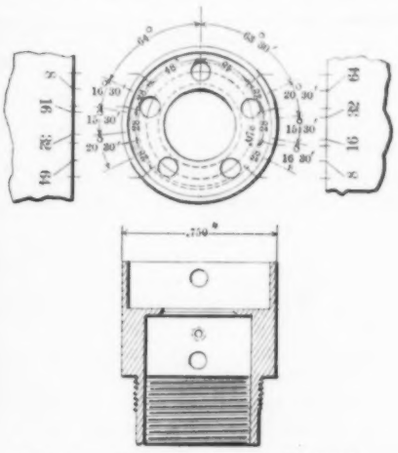


FIG. 1. THE PIECE TO BE MARKED.

milled eight slots *E*. These slots are not directly opposite and had to be located at the exact angles given in degrees and minutes as shown in Fig. 1.

Now these slots retained pieces like those shown in Fig. 3. On one end was engraved the figure, the other being beveled, with a lug underneath. These were held in the slots edgewise, as at *F*, the lugs projecting into corresponding slots in *C*. The function of the boss in the center of *C* is to guide the blank sleeve in Fig. 1, and to prevent the stampers from crushing it.

The punch holder is made of cast iron with a projecting boss on which is fastened the closing ring *G*, the lower edge of which is beveled 30 degrees to match the outer ends of the pieces *F*. The pressure pad *H* insures the seating of the blank until the punch rises. When the punch comes down it drives the pieces *F* toward the center; as it rises, the small springs shown drive these pieces outward and away from the blank until the lugs underneath strike the ring *B*.

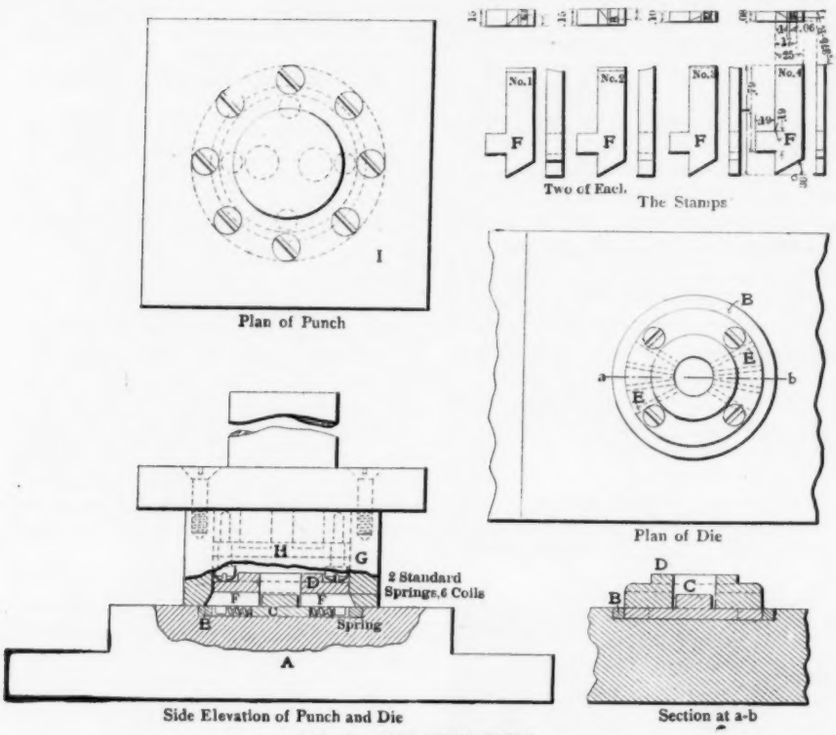


FIG. 2. THE PRESS TOOLS.

I might mention that on the first set I spoiled the piece *D*. I found when computing the degrees for the last slot I was out 5 minutes. But the engraver spoiled the first two sets of figures, so I didn't feel quite so bad about it then.

CARROLL ASHLEY.

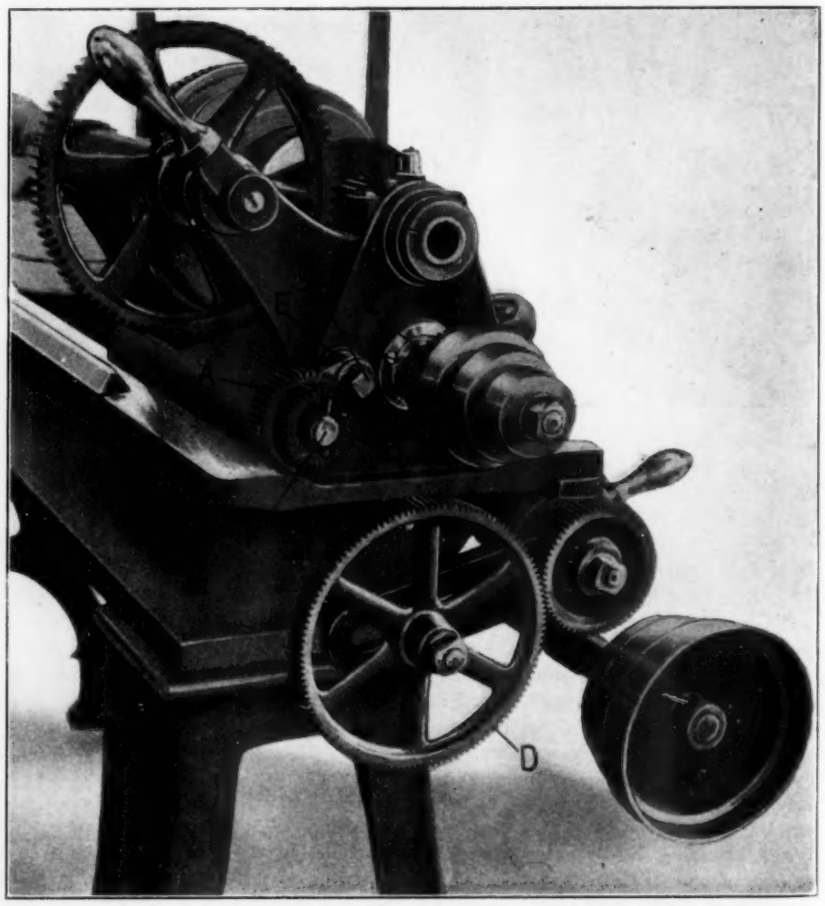
Cutting Worms to Diametral Pitch.

A short time since I had occasion to make a worm gear and worm to carry out an experiment without delay and with as little expense as possible. In other words I had to do the job with the facilities at hand.

There were no hobbing cutters among our limited stock of tools and the only gear cutters available were one each No. 1, 2 and 3 of 12 diametral pitch. Worms and worm gears are usually made by cutting the worm to some screw pitch, which the change gears usually provided will cut, making this pitch the circular pitch of the wheel and computing the diameter on the circular-pitch basis. In the case referred to, assuming the angle of the teeth to be small so that the difference between the real pitch and normal pitch would be of no practical consideration, I concluded to make this wheel and worm conform to the diametral-pitch system, provided change gears could be had to intercept the well known factor $\frac{22}{7}$ as the ratio of circumference to diameter as is done when cutting rack teeth to diametral-pitch wheels, and it occurred to me this could readily be done on the lathe of which the illustration shows an end view. This lathe as placed on the market by the makers has a block *E* which can be clamped in any position by the bolt *G* and carries a stud *F* on which two gears (not *A* and *B* shown) rotate simultaneously, the larger one having twice as many teeth as the smaller. The normal purpose of these gears is, meshed with *C* and *D*, to cut twice the number of threads to the inch shown on the index plate, and it is quite clear that if two gears in the ratio $\frac{22}{7}$ were fitted in place of *A* and *B* the pitch of the screw cut would be the circular pitch of which the number of threads shown on the index plate is the diametral pitch, and worms could be cut in this system to any pitch within the limits of the number of screw threads the lathe is designed to cut. It would seem to be an improvement if all lathes were provided with such an attachment. Hob cutters could then be made to the diametral pitch and worm gears made in this system the same as spur gears are at present.

As stated above the angle of the teeth was assumed to be small, as the angle of single-thread worm gears usually is.

In this case it was desirable to make the diameter of the worm as small as practicable and at the same time obtain an angle that the saddle could be conveniently set to. After a few trials the pitch diameter of the worm was determined on as 1.059 inch which gave a spiral angle of 4½ degrees, the outside diameter of worm being 1.225 inches. The number of teeth in the heel was 45 which at an angle of 4½ degrees 12 diametral pitch gave a



CUTTING WORMS TO DIAMETRAL PITCH.

spiral pitch of 149.69 inches. At first I thought of cutting the teeth across the face at an angle of 4½ degrees, but on further consideration decided to ascertain how near I could obtain a pitch of 149.69 inches on the milling machine at hand—a B. & S. No. 1 universal.

As such a small angle and large table travel for a spiral of 3¾ inches is not given in the tables and as a table travel was obtained within 3/16 inch, nearly, of the desired travel, it is well not to take the table as exhausting all angles and travels that can be deduced.

The table travel being 10 inches for one complete turn of the dividing head, to travel 149.69 inches the screw requires to turn 14.97 times faster than the so called worm in the milling-machine table: hence the ratio of the spiral change gears equals 14.97, or, for a trial example,

$$\frac{100}{24} \times \frac{x}{24} = 14.97,$$

and from this we obtain $x = 86.217$. The gears 100, 86 and two 24's give a travel of 149.306 inches, the difference being of no practical moment when considering the width of the gear face, 7/8 inch.

R. A. NIVEN.

A Speed-Change Device.

I have been much interested in speed-change devices, and have eagerly read the descriptions of those which have appeared from time to time in the columns of the AMERICAN MACHINIST. The following device differs so radically from anything which I have yet seen, that I believe its construction will prove interesting to those who are working along this line. This device was designed to fill the following requirements: A limited movement of the speed-change lever; speed changes to be as nearly instantaneous as possible so that, when changing, the speed of the gears will slacken very little; a wide range of speeds, and a rigidity and strength to make it suitable for heavy duty.

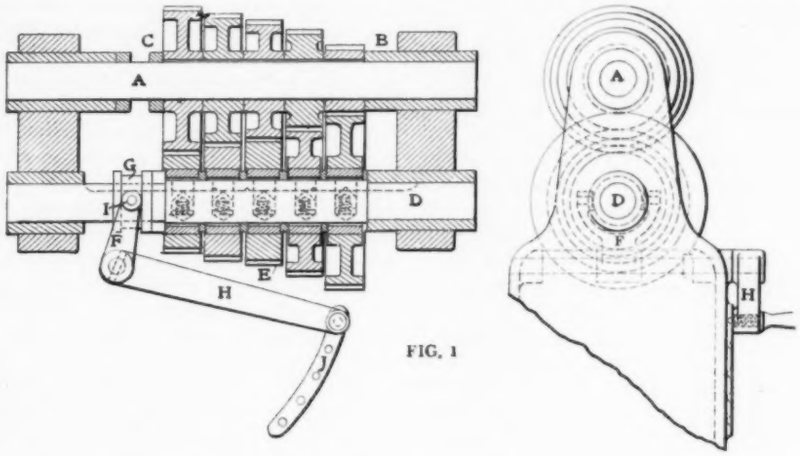


FIG. 1

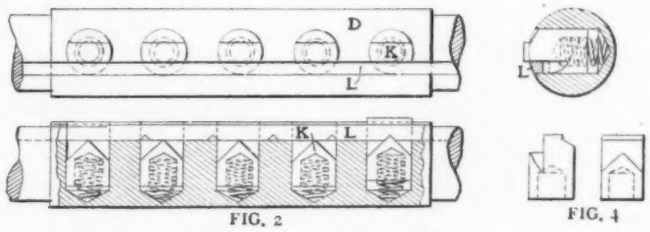


FIG. 2

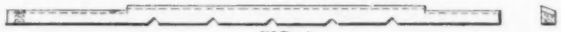


FIG. 3

FIG. 4

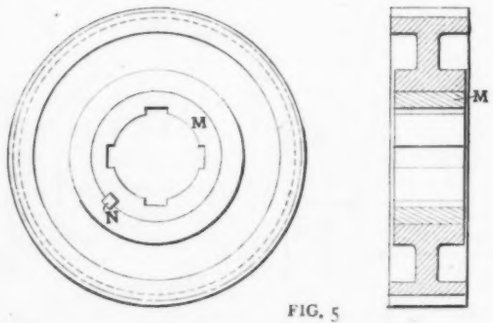


FIG. 5

A SPEED-CHANGE DEVICE.

Fig 1 is a cross-section and end view of the device. Fig. 2 shows the change shaft, Fig. 3 the key bar, Fig. 4 the key and Fig. 5 one of the change gears. In Fig. 1, *A* is the driven shaft, to which the gears shown are solidly keyed. The bushing *B* and collar *C* take care of the end thrust. *D* is the speed-change shaft upon which the gears *E* revolve freely. *F* is a yoke for moving spool *G* by means of lever *H*. On this yoke are rollers which revolve on pins *I* and roll in the groove of spool *G* when in operation. On the under side of the lever *R*, directly beneath the handle, is a pointed pin backed with a spring causing it to spring into countersinks in segment *J*. The countersinks are accurately spaced so as to correctly locate the lever for the different speeds. Segment *J* is a boss cast solidly to the bed. In the speed-change shaft, Fig. 2, are drilled holes spaced so as to face the centers of the gears *E*, into which fit the keys shown in detail in Fig. 4. These keys are drilled from the bottom to accommodate the spring shown and are also milled at the top to form a key surface, and at the front to allow bar *L* to pass in front of them as shown in Fig 4. It will be seen from Fig. 2 that bar *L* is notched and the keys are milled with angular surfaces, which take bearing in the notches mentioned. The bar is also rounded off on top, as shown, to conform with the circle of the shaft when it is in place. The notches are spaced differently from the gears and keys so that any one of the keys will be out of its notch before the next one jumps in. The bushing *M*, Fig. 5, is keyed to the gear with key *N* and has four keyways equally spaced. We found that with only one keyway it sometimes happened that the speed would greatly decrease while changing from one speed to another before the next key would catch, thus causing a sharp impact between the key and keyway, which might lead to serious consequences, if the speed was high and the machine under load. With the four keyways the key takes its place after less than a quarter turn, instead of nearly a full turn as formerly, and there is no perceptible decrease in speed. In Fig. 1 washers will be seen between the gears *E* which are used to prevent the belt *L* from rising under the spring pressure, and catching the gears. A fender, not shown, covers the device.

The large gear on shaft *D* in Fig. 1 is shown driving the shaft *A* as the key is up in the notch in the bar and engaged in one of the keyways of the bushing. In changing the speed the lever *R* is thrown over until it jumps into the next countersink in segment *J*, when the next notch in the bar will be over the key controlling the adjacent gear, causing that key to spring and do the driving. At the same time the notch controlling the key which drives the large gear moves away, thus pulling down the key and throwing it out of engagement. A comparatively short movement of the bar will give the entire range

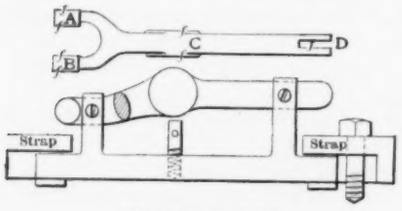
of speeds. This device works very satisfactorily, and for the requirements of our machines is the best we have yet used.

I hope that other readers will describe other devices used regularly on their products, for surely they are the best, else they would never have been adopted. The only way I have been able to learn of them was to go to some new machine received in the shop and examine its original features. Catalogs as a rule give absolutely no information about these devices, but merely state that a suitable or efficient speed change is used. Description of these devices in the mechanical journals I believe would prove beneficial to all readers. L. F. B.

Fixtures for Milling Bronze Levers.

I had to machine some awkward shaped bronze levers, and as there was a large number of them, and it was necessary that they be interchangeable, I found the usual method of planing or milling slow, and unsatisfactory. So I made three fixtures like the one in the sketch, with lugs to fit the miller-table slots and fastening a lever in each finished the four faces of *A* and *B* on miller No. 1 with two pairs of side mills.

The fixture was then placed on miller



MILLING FIXTURE.

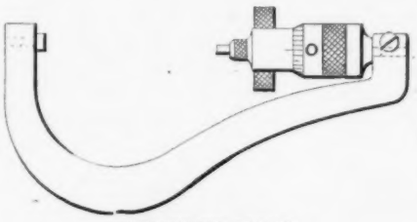
No. 2 where another pair of cutters faced both sides of hub *C*. The slot *D* was cut on miller No. 3, the lever remaining in the fixture for all three operations.

After the milling machines were properly adjusted and all running together I was able to finish the work accurately and at a good rate of speed. E. L. F.

A Micrometer Frame.

Once when I was away up in northern Quebec, overhauling a good-sized sawmill, I loaned my 2-inch Brown & Sharpe micrometer to a young chap who was supposed to be helping me. He immediately dropped the instrument into about 20 feet of ice water where, so far as I know, it is yet.

I had a Starrett 2 to 12-inch inside micrometer; so I forged a sort of frame out of ⅜-inch tool steel, centered it at each end, and with an iron piece placed inside between the ends as a brace, drilled the right sized holes in the lathe, thus getting them in line. The hole at the "working end" was just a nice fit for the little steel tip on the micrometer. The instrument was then placed in position and rotated by a string wound around it and pulled; a hacksaw slot, cut lengthwise into the hole from above, and a small screw to draw the thing tight, completed that end. The other end required only a small steel plug, driven up to a shoulder from the inside, and ground off until the distance between the points was 1 inch as shown by the B. & S. gage, which I still had; this enabled me to set it quickly and accurately.



MICROMETER FRAME.

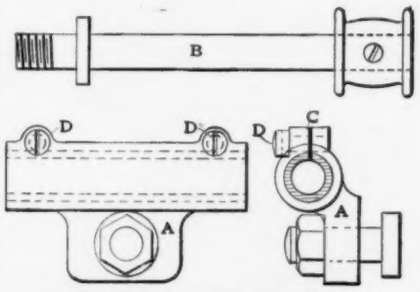
Although when completed, it was not a very handy tool, still it served its purpose, and was much better than sending in a report that such and such brasses or bushes were to be 1 25/64-inch full, etc.

Canada. W. L. McL.

A Drilling and Grinding Fixture.

The illustration shows a little fixture I made some years ago. It was originally intended for grinding, but other spindles were subsequently made for holding drills, etc. Later on I made several of the tools complete with spindles, so that it was not necessary to change over. The body of gray iron is shown at *A*, it was bored roughly about ⅞ inch. The spindle *B* was made of tool steel, the straight part was ground ½ inch diameter. The casting *A* was made so that the center of the hole for the spindle was the same hight as the centers of the lathe on which it was to be used.

After the spindle was made it was slipped through the hole in *A*, mounted on the centers and preparations made for babbitting the bearing, the whole thing, spindle and all, being heated with gas. After the babbitt was set the screws *D* were fitted, the 1/16-inch saw slot *C* was run the whole length of *A* and holes were drilled and tapped for small oil cups. The slot *C* was filled with a piece of raw-hide belt lace to keep dirt out.



A DRILLING AND GRINDING FIXTURE.

On the later spindles I put ball thrusts at each end. One spindle was hollow and fitted with draw-in chucks. The first one made was in nearly constant use for about five years and ran at various speeds between one and ten thousand r.p.m. It gave no trouble and did not wear enough to require either a new spindle or rebabbitting. DIXIE.

Stock-Taking Tools.

I send you a sketch of a set of tools for taking the inventory of pulleys, shafting, belts and hangers, that will repay their cost many times over, to anyone having a line of 200 feet or more to inventory. The construction of the tools is shown so plainly by the sketch, that little or no explanation is needed. The calipers, Fig. 2, are proportioned so that the distance from the points to the rivets is equal to the length of the handle at the graduated scale, which gives the diameter of the pulley which is being calipered.

Fig. 1 is for measuring the width of pulleys and belting; the projection at the end being placed against the pulley or belt, the figures being of a size that can be easily read while standing upon the floor.

The third and last tool in the set is for measuring the drop of hangers by placing the lug under the shaft and allowing the foot to slide up against the floor timber;

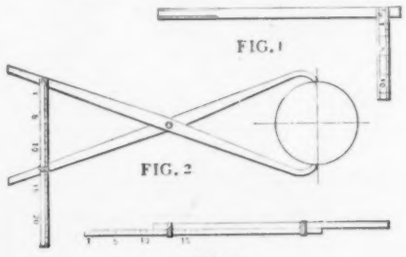


FIG. 3

TOOLS FOR STOCK TAKING.

the drop of the hanger is shown at the end of the tool.

They are used in connection with the checker or clerk taking down the figures as called out by the one doing the measuring. A trial will convince anyone of the efficiency of these tools.

A. P. PRESS.

Straightening Gun Barrels—Feeds and Cuts in Boring.

Referring to the article entitled Straightening Gun Barrels at p. 678, we beg you to inform us what is the advance of the tool per revolution.

H. BOLLINCKX.

Brussels, Belgium.

The hognose or rough-bore cutter is usually given a feed of from 0.01 inch to 0.015 inch, according to the depth of the cut and the quality of the cutter.

The reamer or finishing-bore cutter is given a feed of about 0.01 inch per revolution, but even this is varied to suit the amount of material that is to be removed in finishing. Some shops allow a cut for the finishing reamer of 0.10 inch on each side of the bore, while other shops leave only about 0.03 inch on each side of the bore and get satisfactory results. Per-

sonally, I prefer the shallow finishing cut because the condition of the bore after the finishing cut can be controlled more easily by slight variations of rotative speed or tool feed when the shallow finishing cut is being used. WALTER CANTELO.

Eliminating the Tracer—Suggestions Regarding the Making and Issue of Blue Prints.

Considering the various means employed to reduce the "cost of production," doing away with unnecessary labor is probably best understood, when it results directly in the dismissal of hands hitherto deemed essential—with a consequent saving on the pay-roll. The designers and detailers may be considered necessary factors; if the tracers are to be eliminated a means must be substituted whereby the equivalent of their work may be produced at a saving. Recently the writer had the opportunity of investigating a machine designed with this end in view, which was arranged to coat a drawing made on detail paper with a hot wax solution producing a degree of transparency resembling tracing paper, the lines of the drawing remaining perfectly sharp—the result being that a good blue print might be made from the original drawing thus prepared. When a correction is necessary on the drawing, the wax coating is removed with a solvent which leaves the surface of the paper in its original state; after the correction is made it is necessary to run the sheet through the machine in order to again restore its transparency. It will be seen that this method solves the tracing problem, as an unskilled man may operate the machine, turning out work as fast as it can be run through. So far it must be acknowledged that a saving has been effected; but as no firm would think of using its original drawing each time a print is required, it becomes evident that a brown or black print must be taken from which to make the blue prints. The first cost of one of these machines might also make the adoption of this process prohibitive for small shops, and possibly for large plants, in the face of the fact that the same results may be attained with the plan adopted by the writer, which consists in making the original drawing on a tough, translucent, white paper, from which the brown prints may be made direct—with no processing. With care in the selection, a paper may be purchased that will stand a reasonable amount of erasing and will take pencil and ink as well as any detail paper.

The original drawing is put away in safety, while the brown print is filed in place of the usual tracing. As in the former case, blue prints are made from this brown print, which, however, results in a negative print, having blue lines on a white ground. If it is desired to have white lines on a blue ground as in the regular blue print (from a tracing), a second brown print must be made from the first. This second brown print is called a positive, and resembles the original drawing, insomuch that the lines are dark against a white ground. There is practically no objection to using the negative print for the blue process aside from the difficulty of making alterations on it, owing to the lines being transparent and the ground opaque, which necessitates the use of a drawing fluid that will dissolve this opaque ground where a new line is required, and also wherever it is desired to eliminate a line, the white or transparent line on the brown print must be painted out with opaque ink.

Now, in the case of the second brown print, or positive, made from the first, the ground is white and the lines brown, so it is very easily altered. If it is necessary to draw in some lines, it is done with ink as on the original drawing; and when an erasure is called for an erasing fluid (a weak solution of KOH*) is applied to the objectionable lines, which disappear immediately.

Where this method is used, involving the positive and negative brown prints, it is recommended that one class of work such as patternmaking be done from the negative; so that all the prints, or as many as practical, sent to the pattern shop, have blue lines on a white ground and those sent to the machine departments for example be made from the positive, having white lines on a blue ground. The contrast between the two sets of prints is very desirable and taking advantage of this the system may be elaborated upon to meet special requirements.

At best a tracing is merely a copy of the original and requires very accurate checking, whereas a photo print is an exact reproduction of the original drawing—materially reducing the chances of errors.

Owing to the small outlay at the start it is probably advisable to presume that an interested party would best make some trials along the above lines to satisfy himself on the points which are sure to be brought up in contention with the suggestion of a new plan. It is possible that conditions may be found where the tracer seems indispensable, but so far the writer has failed to find an instance where this system or some part of it could not be installed to advantage.

E. FARRINGTON CHANDLER.

*Potassium hydroxide, caustic potash.—Ed.

Some Peculiar Machines.

The peculiar machines noted by "A Constant Reader of the AMERICAN MACHINIST," at page 780, were doubtless on the same general principles as one I saw described in a newspaper about a year ago. The column was headed "The Fastest Locomotive in the World," and went on to say that some genius had thought out a wonderful scheme by which a gas engine of immense power set on trucks would drive a large generator, which in turn would supply several motors driving very large wheels, about ten feet in diameter. At this point the public was told that because of the increased diameter of the driving wheels one turn of the axle would send the car much farther (truth is stranger than fiction). No smoke or smell was anticipated. The greatest difficulty lying in the way of this truly wonderful machine was the expense of straightening curves on the railroads, as the speed would be so great that the track must be practically straight or frightful accidents would result. Such minor facts as the immense weight and length of any such contrivance were naturally left out and the gentle (necessarily) reader was left to picture himself flying from coast to coast in a single night. The kind of people who enjoy reading such articles rarely remember what they have read long enough to wonder why they never hear more of the thing, and as a certain class of papers find it an easy way of filling up space probably no particular harm is done.

NERALCM.

Indian Engineering has an editorial on the use of motor cars by civil engineers in that country, which is very much to the point, and is in accord with our own ideas upon the rational development of this vehicle. It shows the superiority to horses which would be possessed by an inexpensive automobile, designed for merely a reasonable speed, say 10 or 12 miles an hour, and therefore not requiring pneumatic tires; the machinery designed with a view to simplicity, strength and reliability, not to break records; made without the "gingerbread," which is nowadays characteristic of the millionaire's toy, such a machine to be sold for £100. It does not seem unlikely that after the novelty and glamour of the costly plaything which scoots over the highways at railroad speed without railroad precautions, has worn off, manufacturers will take to developing the more useful side of the business.

The single-phase alternating current system of electric traction has added another steam railroad recruit to its adherents. The Erie Railroad after a thorough investigation which included an examination of American and European electric roads, has contracted for the electrification with Westinghouse equipment of 35 miles of its line, to start with, that is from Rochester to Mount Morris. As on the New Haven, the catenary trolley construction will be used. Niagara Falls will furnish the power.

It is announced that the *Technolexicon* of the Society of German Engineers, regarding which we have made some previous announcements, is so far advanced that printing can begin early in 1907.

Technical Education of the XXth Century.*

The foundation of a technical training consists of nature's laws and phenomena, and as nature's laws are fixed and inexorable, a student possessed of a knowledge of what has been, knows what will be, and it is this that forms the ground-work of the XXth century system of education. But this is not all; it should go further; it should elevate the new generation to a higher plane than mere investigation; it should cultivate powers, a higher ideal and a struggle for genius, the divine, the creative.

An education implies first, a student or scholar to be educated, second, a process or method by which the education is to be acquired, and third, an ulterior purpose or ultimate utilization of the education to some good aim and end.

When the high school or seminary training is finished, several questions present themselves to a young person, among which are three, viz: (1) What shall I do or become? (2) Shall I attend school or become an apprentice? (3) Shall I enter the general or technical courses of instruction? The first question must be answered by the tastes, qualifications and opportunities possessed by the person. The second question is usually determined by the pecuniary limitation of the person. The third question depends upon the advantages to be secured or benefits to be derived, and is a subject for discussion under our topic.

It is not a new subject, but there may be some new things in it, in the light of another's experience. I am not an advocate of an extended general course in college as a condition precedent to technical training.

I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self-reliance which the XXth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends he must gain his experience and acquire a cliental. His married life is postponed and his ideal life shortened by a decade.

In the earlier days of education, theories and laws were assumed by one school, and controverted by others. Fortunately, all this has been changed and modern methods of education are those where observation is cultivated and the reasoning faculties directed to explain the phenomena observed. This is the process of imparting information by directing the student in paths richly bordered with the fruits of wisdom.

The difficulties are removed. The student, though in quest of exercise, has had everything done to lessen the labor. Those obstacles that give to the forest trail its glories, or to the mountain stream its power, have been removed and the Venetian canal has been substituted.

What is the result? It is that all students have been to Venice; all have observed and been taught the same things. The original trend or natural taste of the child or youth has been limited to the banks of your canal. Your graduates are all alike. Genius has been dwarfed and freedom enslaved.

We need to cultivate heroes whose spirits no conventionalities could restrain and who overcome and turn the tide of the world's ignorance, prejudice and jealousies to the light and the truth. They are originators. They have visions unlike the average man.

These limitations in education do not differ solely with the period, but they are greatly affected by the conditions and localities. They are less marked in the smaller and outlying schools than of those in our great communities.

In cities and the great universities located therein, the people forget that the sky overhead is not adamant or lignum. Their chief sources of knowledge are books. Much profitable learning comes from primitive life and from the discomforts of human existence. A millennium of human comfort and convenience is not healthful to intellectual progress nor to physical development.

It is notorious that the strong men and women, those who possess mental and physical superiority, in our schools, in business and in our industrial and professional occupations, are largely from the country.

In the general courses the studies that you pursue are determined, in the larger universities, by the students' own election. The tendency is toward this plan. By it the student may take his collegiate course and at the same time pursue courses required in the professional classes. This will lead to the three years' collegiate course and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect his profession or business, and to take subjects prescribed or acknowledged to be advantageous in the vocation adopted, then it is, to my mind, most desirable. If the student be permitted to follow his own inclinations, which in four cases out of five will be those avenues of least effort, then the system is detrimental. The student may know less at graduation than at entrance. If he elect the elementary subjects in the various departments, acquire what is popularly known as general culture, and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

There is the choice of schools to consider, the large and the small, those in cities and those in country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at a time. The various systems have many advocates. Each maintains that its system is THE system. There is the choice between the elective and the prescribed courses of study, the experimental and the theoretical systems of teaching sciences.

In my opinion, it is those institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses, which prescribe courses for lower classmen and leave the election to upper classmen, that truly derive the benefits of both systems.

Cultivate exquisite care and practice heroic effort. As our country grows older and competition becomes greater, the requirements of an education increase. Students who expect and hope to excel in the competition that prevails in our great cities must have something better or something different from that possessed by others.

Refinement should be applied to all that you do and undertake. Your mental training should be refined on the same plan. Put an exquisite finish upon your work. That is what makes the artist; it is what distinguishes the actor and soldier from the business man or laborer, and it is what makes the successful technician or engineer in the present day.

Technical training as offered by our industrial schools tends to develop abnormally particular lines of the intellect and greatly enlarges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of the five senses. Yet the world has need of such men. He may not be wanted frequently, but occasionally his services are required when they command great prices.

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree as the final goal of his educational ambitions. Few study or expect to study after graduation, except perhaps in short crams for a civil service or professional examination.

Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward, and at a rate

* Abstract of Founder's Day Address, November 30, 1905, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., delivered by John Cassan Watt, M. C. E., LL. B.

that will appal you when you come into competition with some recent graduate fresh from his studies.

A far-seeing man will, before spending very much time or money for a thing, inquire what specific uses he will make of it, and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and sciences by his declaration that he doesn't like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work, it is a grave misfortune for one to school himself or herself in a business in which they have not a real liking and to which they cannot bring enthusiasm. Elect something to your liking and something in which there are opportunities and for which there is a demand.

The utilization of technical training in the industrial pursuits and development is everywhere apparent in this country. To no other one element are the country and the people more indebted for their wealth and prosperity. The physical comforts of home, of business and of travel are due to the marvelous provision of the technican.

The economic value of this training is illustrated by the trade, domestic as well as foreign. No country can have claims to world power until it develops the industrial talents of its people and the natural resources of the land. The balance of power remains where the scientific, industrial and mechanical arts are best treated.

Education of this century should not be confined to book learning nor to the study of mathematical and physical laws. Some time should be given to economics and sociology. Methods and means of conserving and protecting what is acquired are quite as important as are the ways, methods and means of acquiring. Close upon the footsteps of progress in its march is trade, with its competition and its protector, economy. The wasteful methods of the pioneer cannot survive the rivalry of commerce. Economy in the production and utilization of materials or power is what effects great savings, and it is the man who can effect great savings who can command a salary commensurate with his savings.

But the XXth century education should not only cultivate the courage and capacity of a man or woman to cope with nature, but should also give some insight into the laws, institutions and systems of society. It frequently takes some people the best years of their life to become acquainted with themselves and to discover what they really are to the world. Some men take years to overcome the natural diffidence and timidity that possess them, which might be corrected in youth by proper surroundings and by a kindly interest of their teachers.

A discussion of technical education in this century should not omit some reflection upon the social inequalities that are certain to exist. We may look back upon a century mighty in its achievements, gigantic in its forward stride, matchless in its intellectual expansion, industry and invention, in its manifoldness and the vastness of its enterprise, the grandest of all the centuries in history. The heavy burden of labor has been taken from the shoulders of men, and the workman has been made the equal of his neighbor. He has better food, raiment and shelter and better remuneration for his time.

The technical schools should aim to turn out men who can undertake the instruction and improvement of this class of people. Trade schools should be erected and instruction offered in the useful arts. They control the great avenues of commerce, the necessities of life—food, fuel and raiment. Never was there more necessity for the unity of men and the realization of the dependence of the polite upon the industrial.

The education of the XXth century will, I predict, enlighten every continent on the globe. What has been begun in the past century will lead to greater and more lasting results in this century. The XXth century should lead the human race to heights which shall strengthen the faltering steps of art, philosophy and religion.

What the XXth century demands is the cultivation of originality and the development of the creative genius of students. Creation should be the highest aim of every student. A small thing created may be truly greater than a large thing borrowed, and the original thought or design of vastly greater import than any imitation. The present century requires the development of geniuses and especially in the technical fields. Old and trodden fields must be departed from and new, though rough, trails taken. New practices and methods must be devised and these are more likely to be discovered by departure from, than by following in the channels hewn by our predecessors.

The XXth century education should embody artistic treatment in structural work and in mechanical contrivance—a relaxation from the intensely practical and economical to a study of what is pleasing and what is beautiful. Some have an idea that there is not much that is beautiful in the mechanical and industrial. Nothing is further from the truth.

It is for the XXth century education to impart the beautiful and artistic to the useful, to lend inspiration and give expression to the deeper feelings of industrial life, its burdens, its struggles, its rewards and its glorious victories. The XXth century should make its technically educated men something more than mechanicians, something more than the mere directors of processes. Men and women should be taught to vary their employment and to seek recreation in the profitable exercise of their intellectual faculties. The spirit of man needs more than gain, more than crowning success of its efforts, more than the applause of fellow men; it needs the hope and cheer of the life everlasting.

In his own practice Foster Crowell has specified as follows: "Such (steel) plates, and other steel members which are to be entirely imbedded in the concrete, must be carefully washed with acidulated water of sufficient strength to remove all grease and rust, and be well scrubbed; they shall then be washed with a hose jet of clean water neutralized with lime-water, and painted with a thin coat of neat cement just before the final covering with the concrete, which must be mixed and disposed so as to insure complete contact throughout with the steel. Steel members only partly imbedded in concrete, or in situations exposed to moisture acting through the concrete, must be treated, before leaving the shop, with two coats of . . . . after having been thoroughly cleaned, as specified above."

Cast-iron columns should never be used where they have to resist either bending or tension, but there are many warehouses, several hundred feet square, and of low height, where the columns have to carry only a compression load, and in such cases the use of cast iron seems to be perfectly permissible. In many cases cast-iron columns can be had in very much less time than steel columns, and this renders their use desirable, even if difference in price is not considered.

Some years ago the U. S. Weather Bureau re-rated their anemometers, and, disregarding the old Smeaton rule for determining the pressures, worked out a new formula, which they now use. According to this, the true velocity for an indicated velocity of 80 miles is 62.2 miles, and the corresponding pressure is 15.5 lb. per sq. ft. Other velocities and pressures are in the same ratio.

Stone-setters, if not prevented, frequently attach booms to the columns of a building to hoist their stone to position. Hoisting engines are often placed on the first floor, and cause a great deal of vibration. They should either be placed in the cellar or shored up so that they clear the ironwork entirely.

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The index for Part I of the present volume (January to June inclusive) is printed, and is sent with this number to all mail subscribers. We have printed enough also for those who buy the papers from newsdealers and will send a copy to any address upon receipt of postal card request, with full name and address. It is the best and most complete index we know how to make. It is worth having, and costs nothing but a postal card.

Alcohol for Small Engines.

It is announced that Prof. Chas. E. Lucke, of Columbia University, will conduct a series of tests and will gather also the best obtainable data for the publication of a bulletin to be issued about the first of January by the United States Department of Agriculture, on the use of alcohol in small engines. Professor Lucke informs us that he would like to have, for this purpose, information regarding patents that may be owned by any of our readers, and which relate to this subject, and says that if any of them have vaporizers, carbureters, or complete engines, they are invited to submit these to tests to be made in the laboratory, which tests will be conducted without any expense whatever to the owners of the devices, except for the transportation of them to and from the laboratory. Reports from these tests will be published in the bulletin referred to.

As the law removing the tax from denatured alcohol goes into effect about the first of January, this proposed bulletin ought to be of great value to manufacturers, and others who may be interested in the subject of the production and utilization of alcohol for industrial purposes; and while we do not believe in what is called paternalism in Government affairs, it seems that this is preëminently a case in which the Government can do the work much better than it can be done by private individuals, or at least can do it in a way to be of far more general value and helpfulness than it could be done in any other way. No private concern, or at least very few private concerns, would be likely to undertake such a thorough gathering together of information as will be made by Professor Lucke, and if it did would be unlikely to publish the results of its work for the benefit of the rest of the world, as will be done by the Department of Agriculture. We shall hope, therefore, that those of our readers who can coöperate with Professor Lucke in this matter will at once do so, to the end that the bulletin may be of the greatest possible usefulness.

The Demand for Graduates.

We received not long since, a copy of a press bulletin issued by a well known university, from which we quote as follows:

". . ., July 7—The demand for engineers is well illustrated by the fact that all the students who were graduated from the college of engineering of the . . . of . . . had secured positions before the close of the university year. So great was the demand this year that many of the students had two and three places open to them, between which to choose. All of the largest engineering companies in the country sent representatives to . . . to secure all available graduates."

Our contemporary, *Engineering News*, having the same bulletin, comments upon it as follows:

"The conditions set forth in this bulletin are not peculiar to this institution. According to the information furnished us, some of the best known engineering schools had applications for two or three times as many men as they graduated; moreover, the size of the graduating class this year in most institutions was far in advance of all previous records.

"On the face of things, therefore, the university is justified in spreading abroad the announcement that the men who have taken its courses and on whom it has placed its hall-mark are in active demand among employers. That this will tend to further increase the number of students seeking the engineering schools goes without saying. Time was, and not long ago, when the college graduate after he stepped off the commencement stage found that the world had forgotten him while he was pursuing a scholastic life and realized no need for his services. The fact that places seek the engineering graduate today, while his brother with an A. B. degree is even in these prosperous times obliged to seek for a job, is doubtless one of the principal reasons for the astonishing growth of the engineering colleges, in comparison with the colleges of arts.

"But the question which appeals to us, and which we believe deserves most careful examination, is to what extent these applications for engineering graduates really reflect a *bona fide* demand for engineers—a demand, we mean, that is backed up with the ability and willingness to pay liberal salaries for efficient and responsible work. A great number of young men are starting into engineering courses today for no better reason than the certainty of a job at graduation. It is important for them to know not only what the chances are of employment at living wages at the start, but what income may they reasonably expect after accumulating five or ten years of practical experience.

"It is our impression that the men in this grade—the rank and file of the profession—have not experienced increase of salaries and increase of demand for their services in these years of engineering prosperity to any such extent as have the men at the top, or the men at the bottom rung of the professional ladder. If we are

wrong in this matter, we shall be glad to be corrected. Of course, it is true that the engineer of any grade finds it far easier to find work and there is less tendency to screw salaries to a low notch than was the case during the '90's. Our only claim is that the student who gages the relations of supply and demand among engineers solely by the university announcement quoted above is likely to form some erroneous ideas and be disappointed and disillusioned at some later day.

"It may be worth while to refer to some of the conditions under which these applications for men are made. First, as we pointed out in this place some time ago, it is the rule rather than the exception for a man who has a position to fill to send a statement of his wants to two or more colleges and often to half a dozen, or even a larger list. When it is said, therefore, that a college could have placed two or three times as many graduates if it had them, it does not at all follow that if there had been in the whole country two or three times as many engineering graduates, they could all have found positions.

"Analyzing now these applications for men a little further, we find that in a large proportion of them the pay offered is very low and the offer of promotion is held out when the graduate gains experience and demonstrates his ability. No objection can be found to this offer on its face, for the services of the average engineering graduate are not worth any large salary. The only question to raise is as to the employer's attitude of mind. If he is taking the young graduate into his employment with the intention of raising his salary as he becomes worth it, well and good. There is reason to believe, however, that not a few applications sent to the colleges for men, really have behind them the desire to secure technical assistance at low cost. A man who will not go into the market and pay the price a good engineer's or chemist's services are worth, will write to colleges in the hope of getting his work done at a cheap rate. We may remark parenthetically that employers who put responsible testing or investigation work into the hands of green men just out of the schools, in order to save money, are apt in the end to pay dearly for their attempt at economy. It is from men who make experiments of this sort in the employment of college graduates that criticisms are frequently heard as to the training which the college gives its students!"

To this we might add that really pitiful stories reach us concerning the bitter disappointments experienced by graduates and their relatives, who perhaps have strained every nerve for years in the effort to secure a technical education, and who find at graduation plenty of positions offered it is true, but at wages entirely inadequate. And in many cases these extremely low wages continue indefinitely, many being forced finally to forsake their chosen vocation and go into other lines of work in order to make an approach to a decent living. True, here and there a man of exceptional ability (or, alas, with exceptional influence, sometimes referred to as pull) secures a position of responsibility at a fair salary; or, if he have good business ability and can command some capital, he goes into business and succeeds—largely by employing other graduates at low wages, while they are "getting experience."

The colleges, and likewise the correspondence schools, are entitled, we suppose, to refer to their best results in whatever advertising matter they send out.

A milling-machine manufacturer who is setting forth the capacity of his machine to do work does not select for his example the poorest performance he knows of but the best; and rightly so, for the best performance represents the capacity of the machine—tells just what it can do when it has a chance. It is "up to" the buyer to see to it that it has an equal chance in his own establishment. If it has not that equal chance then the buyer must be satisfied with correspondingly lower results.

It would seem as though anyone intelligent enough to be able to make any use of a technical education after obtaining it ought to know that the material that colleges and correspondence schools have to deal with varies in quality through a much wider range than do the different metals that come to a milling machine, and that uniformly and highly successful results ought not to be looked for. It can scarcely be disputed, we think, that education along the lines of one's chosen occupation is an advantage if proper use is made of it. What to do with one's boy "Joe," whether to send him to a shop first or to the technical school first, is a problem difficult enough for many, but a much more difficult one for many people is whether to send Joe to school at all or not after he has graduated from high school. Many variable factors enter into the problem, and those who have it to solve should at least understand that employers do not crowd around the doors of college auditoriums and struggle for a chance to collar young graduates and carry them off to work at high salaries.

The Metric System at Willans & Robinson's.

Those who have been favoring the taking of many or few steps in the direction of using, here and in Great Britain, the metric system of weights and measures have continuously called attention to the fact as alleged by representatives of the firm of Willans & Robinson, the engine builders of Rugby, England, to the effect that the firm referred to had been regularly doing most, if not all, of the things declared to be impossible by those who have opposed the taking of any steps toward the use of the metric system. It is no secret that the latter have found the practice of Willans & Robinson the most effective ammunition against their defenses, and corresponding interest has attached to the announcement made by Mr. Moores, Secretary of the British Weights and Measures Association, to the effect that all the new work of the Willans & Robinson company would hereafter be done upon the inch-pound system. We published at page 686, Part 1, of the present volume, a letter from Mr. Peache representing the firm, which letter put the case in somewhat different light. At that time we said we hoped to be able to publish a communication from Capt. Sankey, who retired from the service of Willans & Robinson recently, and who more than anyone else probably is responsible for the use of the metric system there, always insisting that it was entirely successful and satisfactory. Capt. Sankey, however, does not for obvious reasons feel at liberty to say much about the matter, even to defend his former statements made before professional societies and otherwise; but in response to our request for a statement of his side of the matter, which we urged him to make in view of the facts that he had been widely quoted and that machine constructors everywhere ought to be able to get at the whole truth of the matter, Capt. Sankey writes us a letter from which we are permitted to quote as follows:

"I have read the letter from Messrs. Willans & Robinson, Ltd., published at page 686, and, although for certain reasons I do not desire to enter into a controversy in the matter, I would say that the opinions given in this letter are, except in a few minor points, in agreement with those I have always expressed. The statement that the company is going to make the Diesel engine to metric measures 'with a view to interchangeability with Continental work' and that the metric system 'offers advantages in such work as steam turbines, or other work requiring a multiplicity of small dimensions,' leaves no room for doubt that the company would not have reverted to the English system if their Continental trade had been maintained. The difficulties attending the introduction of the metric system are fairly stated; they amount to want of education on the subject, and to working the two systems concurrently. The obvious conclusion is to make the metric system compulsory."

United States output of brass in 1905, 300,000,000 pounds.

The tensile strength of catgut musical-instrument strings is 60,000 pounds per square inch, the elongation at rupture 15 to 19 per cent.

New Publications.

"Trigonometry Simplified. A Practical Treatise on the Subject of Trigonometry." By C. Chas. Maison. Cleveland, Ohio: the National Book Company. 41 5x7-inch pages + five-place tables of sines and cosines, tangents and cotangents. Price, 50 cents.

In this elementary little book, the measurement of angles, trigonometric functions, use of the tables, and solution of triangles are plainly treated. Oblique triangles are solved by dividing them into right-angled triangles, the neater methods given in more advanced treatises being omitted. Also natural functions are employed altogether, nothing being said about logarithms, which, though sometimes considered somewhat formidable by the uninitiated, are of great value where much calculation is to be done. The type in which the book is set is clear and of a good size, but one's faith in the accuracy of the numerical work is weakened by the presence of numerous typographical errors, such as 52037″ for 52° 37′, and there are also such crudities as the use of two capital I's for the character π. In introducing beginners to new characters they are surely entitled to be taught the correct ones.

"Locomotive Tests: A Compilation by Dr. W. F. M. Goss from a publication by the Pennsylvania Railroad entitled Locomotive Tests and Exhibits by the Penna. Railroad System at the Louisiana Purchase Exposition." American Locomotive Company, New York, 1906. 55 6x9 inch pages, paper cover.

This pamphlet presents, in concise form, an account of the locomotive tests at St. Louis, giving specific information concerning each of the locomotives tested and presenting the results separately for each of the eight locomotives. In the pamphlet four pages are devoted to a description of each locomotive and a discussion of its performance, including a summary of the data of the tests. This is followed by comparisons and conclusions compiled by Dr. Goss from the very elaborate record of the tests issued in book form by the Pennsylvania Railroad, some of which data were published in the AMERICAN MACHINIST, page 331, Vol. 29 Part 1. While the pamphlet does not add to the information given in the book, it presents the conclusions and comparisons in form for convenient reference.

A steamboat built for the New England trade of the Eastern Steamship Company, launched late in April at Roach's shipyard on the Delaware, is stated to be the first turbine vessel built in the United States. She has three screws, the center one being driven by the high-pressure (Parsons) steam turbine, and the outer ones by the low-pressure and astern turbines. Her length on the water line is 290 feet.

Locomotive Bolt-Turning Machine.

EDITORIAL CORRESPONDENCE.

The accompanying illustrations show a bolt-turning machine intended more especially for turning the numerous taper bolts used in locomotive construction. The machine is the invention of C. K. Lassiter, of the American Locomotive Company, by which company it is in large use.

The general construction of the machine will be apparent from Fig. 1 while Fig. 2 shows the construction of the cutter head. A stout ring *a* contains six segmental blocks *bbb*, *ccc*, of which *bbb* are bolted to the ring while *ccc* may be forced inward by the wedges *ddd* and flanged screws *eee* and thereby clamp the cutters *fff* and guide pieces *ggg*. The cutters and guide pieces are in turn backed up by adjusting wedges *h* which are operated by flanged screws *i*. It is apparent that the clamping segments being loosened, the cutters may be adjusted to the desired size and then secured in position by tightening the segments.

Heads similar to the ones shown in Fig. 2 are in place in positions Nos. 1 and 3 of Fig. 1, counting from the observer these being the finishing heads. Heads Nos. 2 and 4 are modified and carry but two cutters and two guide strips and are used for the roughing cut. Of these no detail is shown.

The adjustment of the cutters to taper is obtained in the grinding, for which a special machine is provided, and to diameter by a plug inserted in a support placed in the bottom of the cutter head.

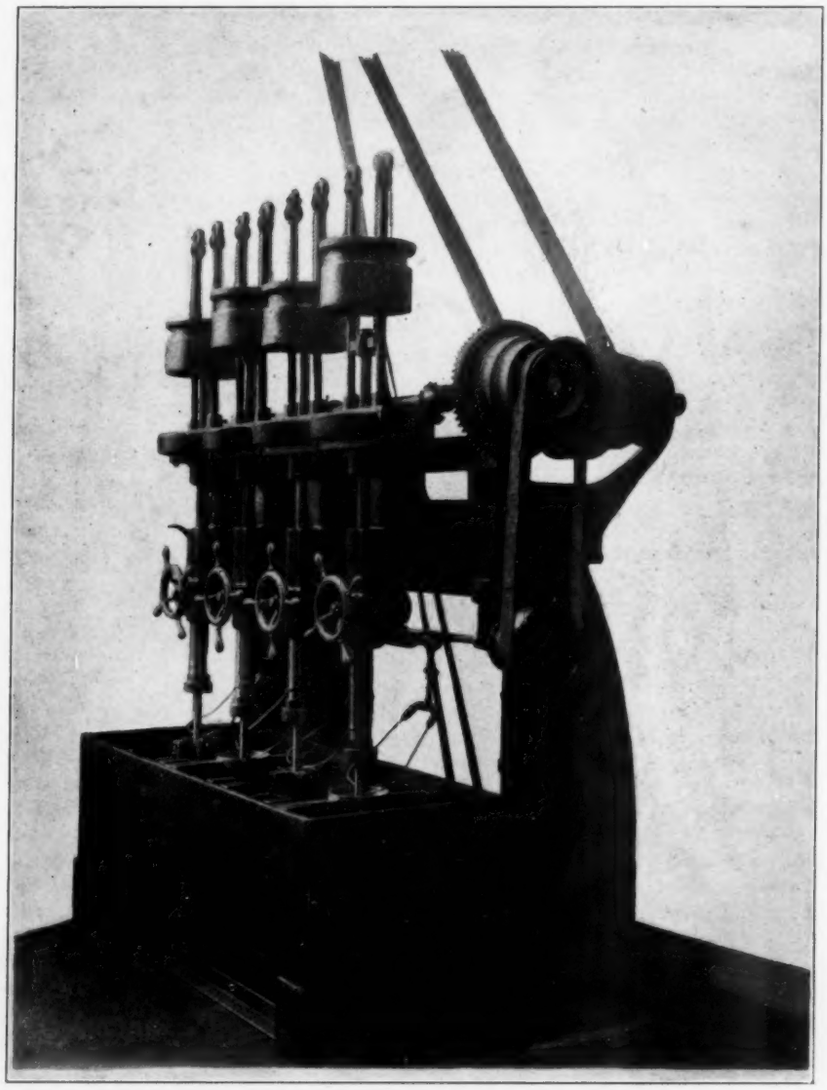

FIG. 1. THE LASSITER BOLT-TURNING MACHINE.

The machine shown is made in two sizes, which turn bolts from ¾ to 1⅜ inches diameter, and up to 18 inches in length. The capacity is remarkable, the machine being equal to roughing and finishing 100 7¼x9-inch bolts per hour.

In the system of measurements used with the machine, the bolts of a given nominal size are of fixed diameter at the small end and increase at the head end 1/64 inch for each increase of three inches

in length. The reamers used for the bolt-holes have stop collars by which the holes may be reamed to a uniform fit. By cutting off the end of a stock bolt which is too long for a given purpose, a bolt may be obtained of any desired length, and the hole may be reamed to suit without disturbing the adjustment of the reamer.

F. A. H.

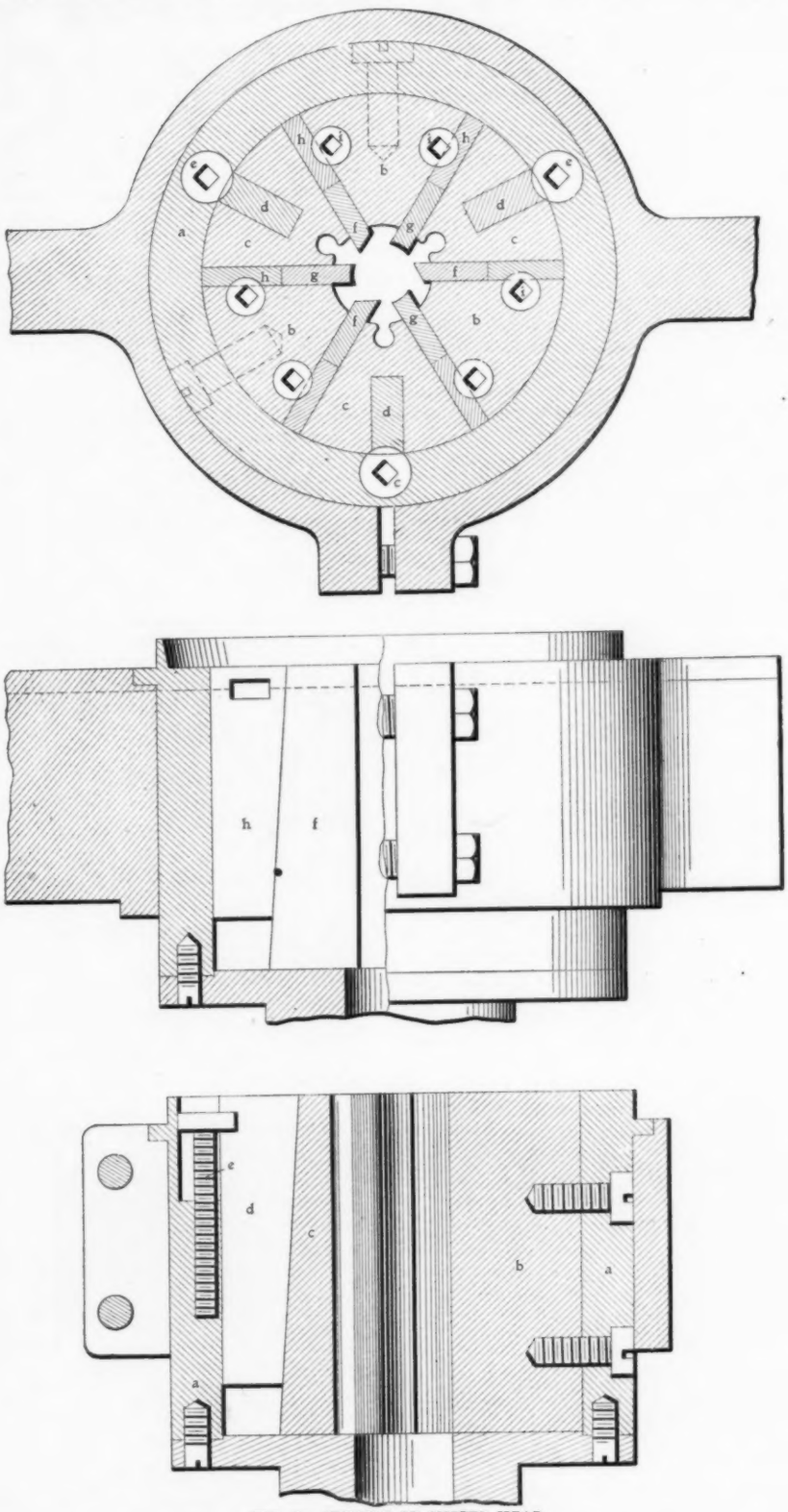

FIG. 2. DETAILS OF CUTTER HEAD.

A cotton loom, said to be the oldest in existence, has recently been discovered at a farmhouse near Chattanooga, Tenn. It has been in the possession of a family of the name of Snow for over 100 years, and is still in active service. It was built by an ancestor from trees which he hewed and is an interesting though somewhat rudely constructed machine.

Bequests by Mr. Webb.

It is announced that the late Francis W. Webb, who was for many years chief mechanical engineer of the London and Northwestern Railway, left considerable bequests to charitable objects of various kinds. He left an estate valued at upward of a million dollars, most of which has been bequeathed to various charities in which he was interested. The benevolent fund of the Institution of Civil Engineers receives £5,000; £2,000 is given to Owens College, of Manchester, to maintain a Webb scholarship for London & Northwestern Railway employees or their sons; £2,000 is given to endow a bed, preferably for London & Northwestern Railway employees in University College Hospital; £2,000 will go to University College, Liverpool, for a scholarship similar to that at Owens College; £1,000 is given to the Institution of Civil Engineers for Webb prizes for a paper on railway machinery. There are bequests to relatives and friends totaling £83,000, and the residue of the estate, £75,000, is to be devoted to the erection and endowment of an orphanage at Crewe for the children of deceased employees of the London & Northwestern Railway. Mr. Webb was never married.

The Premium Plan in the Washington Navy Yard.

We learn by a press despatch that Captain Leutze, commandant of the Washington navy yard, has made a recommendation to Acting Secretary Newberry that the naval gun shop at Washington be placed on either the piece work or the premium plan. The latter alternative appears to be offered as a concession to the machinists' union by recognizing the right of the union to set the maximum output for a given wage.

The labor unions represented at the Washington navy yard have asked for an opportunity to be heard on these propositions, and Acting Secretary Newberry has assented.

Erratum—The Paxson-Hall Molding Machine.

Through some mishap the printers dropped out a line from the left-hand column of page 100 just below the illustration. The first portion of the sentence in question should read: "Thus, if he has no air plant installed and does not intend to put one in, he can buy the machine with a hand-lever drawing table and without the ramming head, and do his ramming by hand;" etc.

U. S. Ordnance officers are carrying on a series of tests with a new bullet which is expected to supersede the one used at present in the ammunition for the new magazine rifle. The new bullet is jacketed, but is sharper than the earlier form.

Personal.

The Newton Machine Tool Works, Inc., Philadelphia, Penn., whose president, Charles C. Newton, died recently, has elected new officers as follows: President, Harry W. Champion; treasurer, William M. Graham; secretary, Ellis J. Hannum.

Obituary.

Loring Coes, of the Coes Wrench Company, the inventor of the wrench which bears his name, died at his home in Worcester, Mass., July 13, from old age. He was 94 years and 6 months old and up to the time of his illness, which began a few months ago, he had the reputation of being the oldest man in the country actively engaged in the management of a big manufacturing concern.

The Simplon tunnel has had to temporarily fall back in part upon steam locomotives with "smoke-consumers," as a new difficulty has been experienced upon the introduction of the three-phase electric locomotives which were lent by the Valtellina Railway until the Swiss railway people shall have secured their own. It appears that these locomotives, which take up the greater part of the tunnel cross-section, when they go from the cool outside air into the tunnel atmosphere, which is warm and very moist, become covered with a profuse condensation. Some of the motors have broken down, it is supposed because of the moisture penetrating the insulation. Modifications are being made to adapt the motors to these new conditions. This is another instance of the difficulties which are encountered by the workers in any new line of engineering, and we have no doubt it will be overcome as many other difficulties have been, not only in electric traction but in other work also.

Manufacturers.

The Clark Engine Company, Jackson, Mich., will erect a plant.

The Lansing (Mich.) Wheelbarrow Company will enlarge its plant.

Norcross Bros. Company, Worcester, Mass., will build a new boiler house.

The Lynn (Mass.) Grease Extracting Company will erect a new factory.

The Carbondale (Ill.) Clay Manufacturing Company will erect a new plant.

The International Miniature Railway Company, Elgin, Ill., will erect a new pant.

The Crescent Belting and Packing Company, Trenton, N. J., will build a new mill.

Small Brothers, Fall River, Mass., will build a two-story addition to their rope factory.

T. Shriver Company, New York, is taking figures for a foundry to be erected at Harrison, N. J.

The American Fork & Hoe Company, Frankford, Philadelphia, Penn., will erect a new factory.

Phillips Brothers, manufacturers of shoe machinery, Rochester, N. Y., are to erect a new factory.

A $12,000 addition will be built at the plant of the Newark (N. J.) Watch Case Material Company.

The Chattanooga Railway Company will build car-repair shops at Knoxville, Tenn., at a cost of $125,000.

Spang & Company, of Butler, Penn., will erect a plant in Tulsa, I. T., for the manufacture of oil-well supplies.

The Denver (Colo.) Gas and Electric Company has secured a permit for a two-story addition to its power plant.

A $3,000,000 glass plant is shortly to be erected in Crystal City, Mo., by the Pittsburg Plate Glass Company.

The Malleable Iron Company, Marshall, Mich., a new concern, will put up a foundry. S. F. Dobbins, is president.

A. H. Wells Company, Waterbury, Conn., which manufactures brass and copper tubes, has let contract for a new factory.

The Economy Manufacturing Company, New Haven, Conn., making artificial stone bath tubs, is erecting a new factory.

The National Lumber and Manufacturing Company has been incorporated at Walnut Ridge, Ark., with a capital of $10,000.

Plans have been prepared by the Schenectady (N. Y.) Railway Company for a machine and repair shop to cost about $150,000.

The Gould Coupler Company is building an addition to its steel-casting plant at Depew, N. Y., which will mean 800 more employees.

The mill of Pennock & Brosius, millers, lumber, coal, etc., at Arondale, Penn., which was recently destroyed by fire, will be rebuilt at once.

It is said that the Hayes Machine Company, of Brooklyn, N. Y., manufacturers of box-making machines, etc., will move to Kingston, N. Y.

J. L. Weston, P. O. Koffyfontein, Orange River Colony, South Africa, would like catalogs of machine tools, small tools, etc., together with discounts, terms, etc.

It is reported that Swift & Company, Chicago, Ill., have nearly completed plans for additions to the plant, which will include car shops, soap factory, canning department, etc.

The Acme Truck and Tool Company is being incorporated at St. Louis, Mo., with a capital of $600,000. A plant to employ 400 men will be erected. Frank G. Koehler, president of the Standard Truck Forging Company, St. Louis, is the principal stockholder.

The Macungie (Penn.) Brass and Manufacturing Company is to add a new machine shop, foundry and engine house and wishes to install a 60-horse-power automatic cut-off engine, an 80-horse-power boiler and complete electrical equipment. All bids to be in by 12 o'clock noon, July 28.

Catalogs.

The Bradford Durfee Textile School of Fall River, Fall River, Mass. Catalog for 1906-1907. Illustrated, 78 pages, 6x9 inches, paper.

The Pickering Governor Company, Portland, Conn. Catalog No. 19-6 describing governors. Illustrated, 21 pages, 6x9 inches, paper.

Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass. Bulletin No. 149, illustrating and describing polyphase induction motors, small sizes. 8 pages, 8x10½ inches.

The Globe Machine and Stamping Co., 3900 Hamilton avenue, Cleveland, O. Catalog of improved oblique tilting tumbling barrels. Illustrated, 16 pages, 3½x6 inches, paper.

H. H. Franklin Manufacturing Company, Syracuse, N. Y. Booklet describing the results obtained by the Franklin die-cast process of producing small finished parts. Illustrated, 3½x6 inches.

Catalog notice in issue of July 12 to the effect that we received list of second-hand metal-working machinery from E. W. Bliss Company, Brooklyn, N. Y., was a mistake. This concern does not deal in second-hand machinery.

Whiting Foundry Equipment Company, Harvey, Ill. Catalog No. 45, describing electric travelers and cranes of all types. Printed in two colors and designed to place in sectional catalog binder issued by this company. Illustrated, 162 pages.

Emerson Electric Mfg. Co., St. Louis, Mo. Bulletin No. 3110, illustrating and describing single-phase induction motors. Bulletin, No. 3203, direct-current motors. Bulletin No. 3204, bipolar enclosed motors. Bulletin No. 3802, motor-driven air pumps.

Westinghouse Companies' Publishing Dept., Pittsburg, Penn. Pamphlet, "The Economical Lighting of Industrial Plants," which describes the Cooper Hewitt lamp. Illustrated, 29 pages, 5x8 inches, paper. Pamphlet illustrating and describing the Nernst alternating vertical glower street-lighting system.

Baldwin Locomotive Works, Philadelphia, Pa. Record of recent construction, No. 56, describing the Atchison, Topeka & Santa Fe Railway system. Illustrated, 29 pages, 6x9 inches Record of recent construction, No. 57, describing common standard locomotives of the associated lines. Illustrated, 23 pages, 6x9 inches.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Agents to sell all kinds of counting machines. R. A. Hart, Battle Creek, Mich.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Good second-hand 36 or 48-inch gear cutter, also radial drill. L. A. Rockwell, 9 Elizabeth St., N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—9 or 11-inch engine lathe, 4 or 5 ft. bed, for general repair work. Address *Evening Leader*, New Haven, Conn.

Wanted—One Brown & Sharpe, No. 2, wire feed hand-screw machine. Geo. W. Dover Co., 80 Clifford street, Providence, R. I.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Wanted—Present address of P. J. Baucher, formerly with the Standard Water Purifying Co., Cleveland, Ohio. Kindly address The Cleveland Twist Drill Co., Cleveland, O.

We have a modern machine-shop equipment and are prepared to design and build to order high-grade special machinery and tools. Cummings Machine Co., 182 William st., New York.